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Shaper Work and Fixtures.

BY A. H. CLEAVES.

Thinking some home-made fixtures and methods may be of interest, the following description of index attachments and other features is presented, with accompanying cuts. Fig. 1 is an index attached to the cross-feed screw on a small Lodge & Davis shaper, such as we have in use here.

Fig. 2 is a similar device on the vertical feed, and Fig. 3 illustrates a fairly good method of cutting a rack of any length on square or round material—in this case, a brass tube for an optical tool.

Figs. 4, 5 and 6 show the advantage of clamps in connection with shaper work in a variety of ways.

In Fig. 1, *A* is the feed screw, having a square thread with 4 pitch, and *B* shows the end of automatic feed attachment between the handle and the index.

The part of *A* shown in section was turned down to get a shoulder for the index plate to hold against, and is threaded part of the way for the binding nut *D*. This is knurled or notched on the edge. Three springs like *F* are placed in *D* to hold the collar *E* against *C* when loosened. This permits moving the index plate to any desired place without vacillating on the point *G*, making a friction contact.

This beveled collar has a key *H* to prevent its turning on *A*, and it slides in *A* at *I*. There is space enough between *B* and the shoulder on *A* to loosen the nut *D* and collar *E*. The point *G* is secured in any convenient way to the solid part of the shaper, and the shaper angle-bed is seldom used close up to the index plate.

The index is graduated 250 divisions, giving one thousandths, while the vertical screw being eight threads, the index is divided into 125 spaces.

In Fig. 2, *A* is the binding nut; and *B*, the collar, has a pin entering the groove *E* to keep it from turning. *C* and *D* are the index ring and point, respectively.

In Fig. 3, *A* is the chuck holding the work *B*, which in this case is soldered at three or four points *D D* to any piece of flat metal *C* of sufficient length, for the purpose of preventing its turning when moved in the chuck. *C* can be clamped to *B*, possibly, and if many pieces are to be cut, and accuracy desired, *B* can be held in a box that can slide in the chuck.

For a cutter, any standard rack cutter can be attached to a piece of tool or other steel, and held in place with screw and pin *G*.

Having determined the lateral pitch of the rack or distance, in one thousandths, between centers of teeth, set the index plate *C*, Fig. 1, at *O*, and move the required number for each cut, getting the depth with index in Fig. 2. Set the index at *O* when the cutter touches top of *B*, Fig. 3, and sink required number of thousandths.

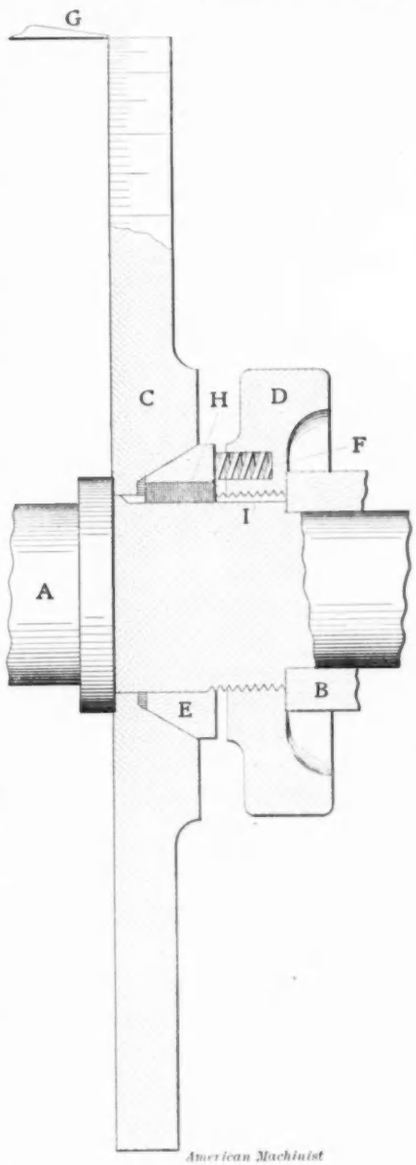


Fig. 1

MICROMETER FOR CROSS FEED OF SHAPER.

I have found the method illustrated in Fig. 4 a very convenient one for cutting up sheet metal into strips, etc., in place of getting the chuck off and fastening the work to the shaper.

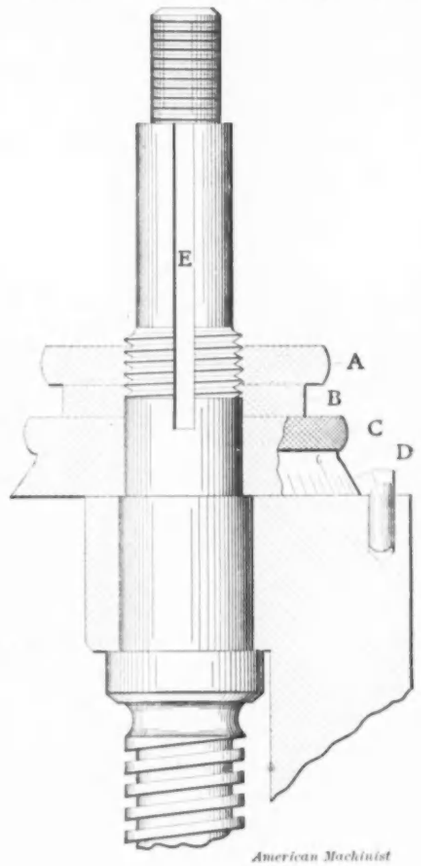


Fig. 2

MICROMETER FOR VERTICAL FEED OF SHAPER.

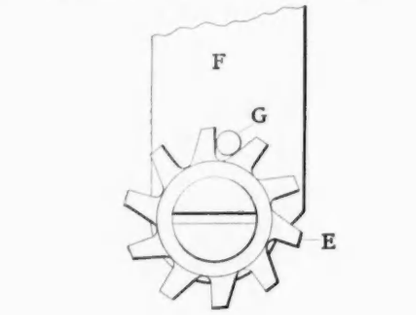
The clamps *A* are made now for the trade very nicely, being case-hardened and milled in every direction to standard dimensions. They run from small to very large sizes, and in sets of three can be utilized in endless diversity. And it is surprising how much even the smaller sizes will hold.

B, Fig. 4 is a parting tool in position;

C the work, and *D* a supporting piece of stock found at random. The pieces can extend beyond the chuck, as shown in milling-machine chuck in Fig. 6, in another operation. Two clamps or more hold the work *C* to *D*, while *D* is held in the chuck.

Figs. 5 and 6 show a thin piece of projecting stock held sideways while being worked in shaper or miller.

In Fig. 6 a long, thin strip is held in a milling-machine chuck, and supported sideways, as shown by dotted lines and in Fig. 5, and also vertically by pieces *A A*,



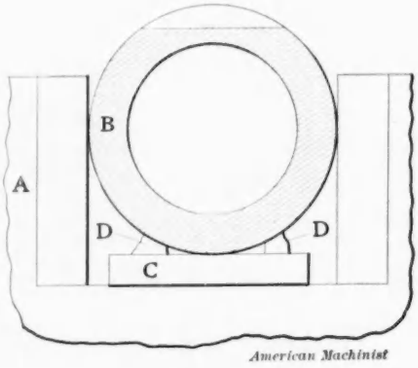


Fig. 3

CUTTING RACKS IN SHAPER.

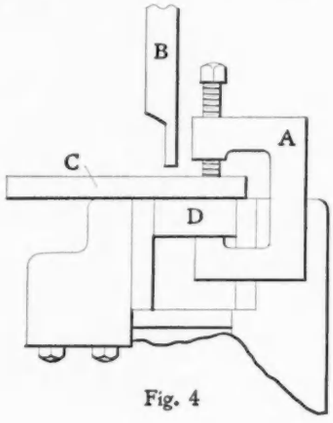


Fig. 4

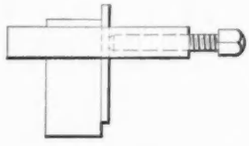


Fig. 5

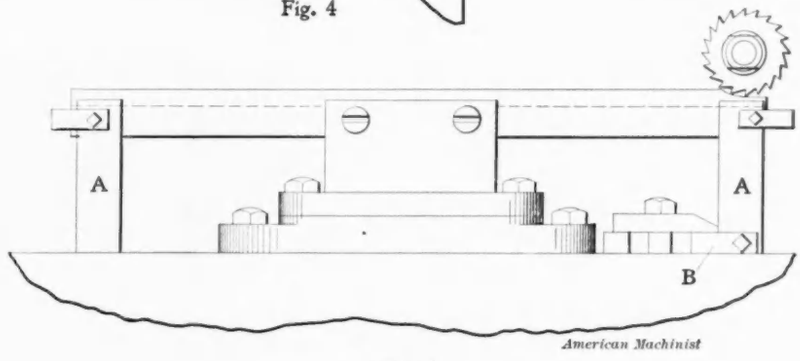


Fig. 6

UTILIZING CLAMPS FOR HOLDING WORK.

Fig. 6, resting upon bed of milling machine.

If the work is likely to lift, catch it again as shown at *B*, Fig. 6.

Chicago, Ill.

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The Earliest and the Latest of the Ironclads.

Before the Contemporary Club of Philadelphia, on December 14th, Mr. Charles H. Cramp delivered an address of great interest on "Naval Armaments at the Close of the Eighteenth and the Nineteenth Centuries." We subjoin a few extracts:

"My familiarity with the subject of battle ships commenced when, as a very small boy, I witnessed, at the old Philadelphia Navy Yard, the launch of the last and greatest American battle ship of the sailing era, the 120-gun three-decker Pennsylvania.

. . . . . .

"During my early operations and training in shipbuilding the wooden ship was paramount, and all the principles that then pertained to the profession of a naval architect at present remain unaltered. In fact, the professional training of that time was of the highest character, involving the necessities of genius, enthusiasm, high artistic tastes and constructive abilities, as well as mathematical adjunct.

"Transatlantic navigation in the packet ship and in the China and Oriental clipper had, during the first twenty years of my experience, arrived at its highest state of perfection, and the ocean contests between the great master builders were confined to American-built ships, the foreigners being out of the race.

. . . . . .

"When iron was introduced the falling off in the character of the design and professional technique was something fearful. The new ships lacked that something in their make-up that impressed one when the old battle ship, the old frigate, the sloop-of-war, the Liverpool packet, and the China and California clipper appeared in view. From that point of view my career as a designer and builder of battle ships may be said to have begun with the New Ironsides, which marked as long a stride from the old three-decker as the modern twin-screw, mastless steel battle ship marks from the Ironsides herself.

. . . . . .

"When the contract was made wages for shipwrights were $1.75 per day. In less than two months they rose to $3 a day. We contracted for all the copper the day after signing the contract at 29 cents a pound; in four months it was 60 cents a pound. Materials went up from 50 to 100 per cent. before we finished the ship.

. . . . . .

The armor plate was made partly in Pittsburg and partly in Bristol, and was of hammered scrap-iron. It was 4 inches in thickness, and the plates were then looked upon as marvels of heavy forging. Generally speaking, she was the pioneer seagoing armored battle ship. She was the first ship of that description to fire a gun at an enemy. She fought more battles than all the battle ships, past and present, put together. In her day she was the most formidable sea-going ship afloat.

. . . . . .

The first and the latest sea-going battle ships built and delivered to the government by Cramp were the New Ironsides, built in 1862, and the Iowa, built in 1897. Each represented, or represents, the maximum development of its day. The New Ironsides had one machine—her main engine involving two steam cylinders. The Iowa has seventy-one machines, involving 137 steam cylinders.

. . . . . .

In the Iowa it may always be said that nothing has to be done by hand. Her guns are loaded, trained and fired, her ammunition hoisted, her turrets turned, her torpedoes ejected, the ship steered, her boats hoisted out and in, the interior lighted and ventilated, the great searchlights operated and orders transmitted from the bridge or conning tower to all parts by mechanical appliances.

Teachings of a Drill Factory.

BY JOHN RANDOL.

Having had occasion to pass some days in study of the details of the manufacture of twist drills as carried on by the T. & B. Tool Company, Danbury, Conn., I was very much impressed by the system of turning drill bodies there practiced, and obtained permission to take photographs showing every step of the process, and also pictures of the drill-straightening operations, and some of these are presented herewith.

The milling cuts made by the T. & B. Company in grooving and body clearing their drills, leave the smoothest and most perfect surface I ever saw on milled work. This smoothness is due to the rigidity of the mill-spindle and work support, flooded lubrication, and cutter-grinding appliances, original with this shop, which give the drill grooving mills teeth of so nearly the same shape that they may be said to be exact duplicates of each other. Of course, the tool-making and the cutter-grinding machines are of the highest class; but even so, the cutter grinding is of surprising accuracy, and the revolution mark made by the mills is so slight as to be barely perceptible to the eye, and not measurable in depth, as it takes a lace-mesh form and is so shallow as to escape notice if not especially sought for. Practically, these drill-grooving mills may be said to cut perfectly, each tooth cutting a chip, and all chips appearing exactly alike. These mills are worm-driven, and have a feed or half a thousandth of an inch per tooth and a surface speed of 40 feet per minute at the largest diameter, with very abundantly flooded lard oil lubrication, the shop being piped to carry the oil from all tools to the oil-purifying machines, and the purified oil being constantly pumped back to the cutting tools, all according to latest practice in the screw machine shops. The cutter surface speed is very low, for the lubrication and support conditions, owing to the high carbon steel used there for twist drills. The "body clearing" cut, which clears the "lands" of the drills half of a circular degree, is a very delicate operation, as the depth of this cut, in the smallest sizes of drills, is only half a thousandth of an inch at its deepest point. It is almost needless to say that all the important adjustments of the grooving and body clearing machines are made by micrometer screws, and that both types of machine, in their various sizes, are what may be fairly called examples of the best machine-tool designing and construction.

The heating for tempering is done in pots of pure lead, and the hardening is done in a circulating bath, both the furnaces and cooling vats being of peculiar construction, but involving no principles of cooling not already described in these columns.

The whole manufacture of twist drills is inspected at every step of making. The stock is ordered of specified constitution, and is tested by fracture and chemical analysis, and is measured for the wire drill sizes by the micrometer before anything else is done to it, and the turned drill blanks are measured by the turners with snap gages and bench micrometers, all three, and finally every drill blank is measured by the foreman of the turning department.

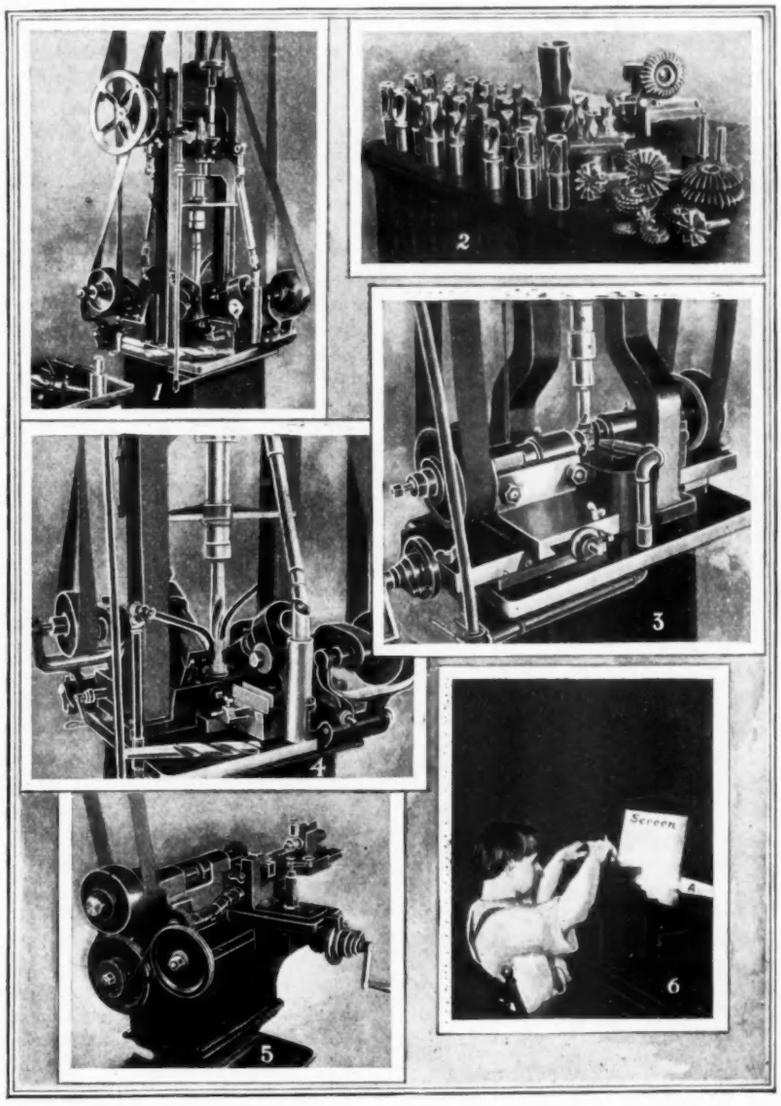

Fig. 1—DRILL GROOVE MILLING MACHINE. Fig. 2—GROOVING BUSHES, GROOVING MILLS, BODY CLEAVING MILLS AND GROOVING MILL GRINDING MILL FIXTURE. Fig. 3—VERTICAL BODY CLEAVING MACHINE. Fig. 4—LARGE DRILL GROOVING MACHINE. Fig. 5—HORIZONTAL BODY CLEAVING MACHINE FOR SMALL DRILLS. Fig. 6—COLD STRAIGHTENING WIRE DRILL BLANKS.

The cutting off, centering and turning of the drill blanks are of general interest, as they are all performed with commercial tools, and represent the final selections of methods made by the company from many experiments, all looking towards the cheapest and most practicable methods of producing short lathe work accurately sized.

The hand file is as much the final resort in blank sizing as the hand micrometer is in gaging. The high carbon stock is hard to turn, hard on the cutting tools, and pieces from the same bar do not come off the lathe the same diameter with the same tool setting. Hand-lathe filing and hand-micrometer gaging are the final dependence. The limit is a quarter thousandth under size, nothing over, and is rigidly adhered to in all cases, drill blanks under size being turned down to the next size below, at the workman's expense.

Except tool-making, most of the work is done by specialized laborers—youths who have never worked in the shop being preferred as raw material for operatives.

Beginning with the wire sizes of drills, the hand micrometer is used in gaging the drill rods in 10-foot lengths as they come into the shop. The inspection is for diameter and roundness, both, nothing what-

ever being accepted without the hand-micrometer approval.

The smaller sizes are cut to length on a little lever cutter. This machine is of the well-known form consisting of a tool-steel disk pivoted to a bracket provided with a circle of hardened bushes of different sizes registering with holes in the disk, which is rocked by a hand lever to

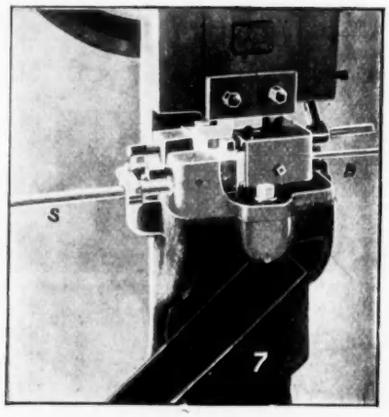

Fig. 7. CUTTING OFF DIES.

separate the blanks from the rod which is passed through a suitable hole in both bush and disk.

The larger sizes of wire drill blanks are cut from the rods on a P. & W. screw-shaving machine, with a 60-degree V-cutter. This cutter is made in the form of a disk, and has a notch ground in it to make the cutting edge, thus obtaining all the advantages of long life and uniform production due to that form of cutter, first introduced by the watch shops, I think. Cutting off with this 60-degree V-cutter gives both ends of the blanks the 30-degree angle which is required at the point, and used also at the shank end of wire drills. The smaller sizes of wire drill blanks have square ends as they come from the cutting machine. These blanks receive the 30-degree angle at both ends in a double head pointing machine. The blank is held by a friction clamp, and both heads are brought up until one touches the blank end, then the clamp is slightly released, so that the blank can slide along in the clamp until the other end meets the other cutter; then the blank is clamped firmly, and both heads are brought up to a stop by the operator. This method brings all the blanks precisely the same length after pointing.

The wire drill blanks are next straightened as shown in Fig. 6, which is a reproduction of a flashlight picture, all of the straightening operations being carried on in individual rooms, black muslin curtained and screened to suit each workman. In Fig. 6 the room is dark, except for a narrow horizontal bar of light admitted at *A*, and passed through a white muslin screen on a frame in front of the straightener, who uses a small copper hammer to straighten the drills laid singly on a heavy cast-iron surface block, the top of which is exactly eye-high for the operator, as he sits at his work, with the hammer in his right hand and a fan of drill blanks between his left thumb and forefinger. A blank is dropped on the surface block and rolled under the hammer face, thus showing light under the crooks of the blank. This operation depends entirely on the eye, and is performed with incredible celerity and great accuracy, the blanks appearing to be absolutely straight; although they drop so rapidly from the surface block into a box at the rear as to make it seem impossible that the straightener should know whether he has made them right or not.

The next operation is filing the taper clearance on the part of the blank which is to be grooved. The machine used is a Brown & Sharpe filing lathe, with knee-operated pull-back collet and foot friction brake. The files used are Nicholson dead-smooth, 6 inches long by ½ inch wide, and 8 inches long by 1 inch wide.

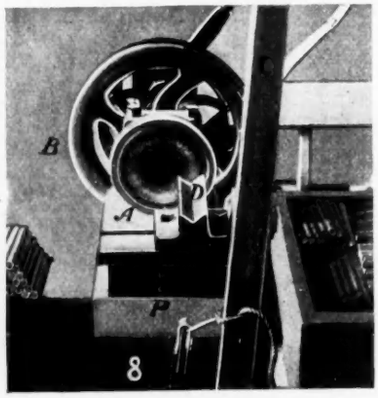

Fig. 8. BLANK END MILLING MACHINE.

This is an operation performed with great skill by the filing boys, who almost invariably bring the blank to the exact taper required at the first trial. The taper given to the blanks is from half to three-quarters of a thousandth per inch of length, and is made with such accuracy and perfection as to give one a new sense of the possibilities of hand filing, as the blank filers, while they do pay attention to their work, do not seem to give it extreme or unusual attention.

Filing the body clearance completes the operations on the wire drill blanks, which go from the filers to the grooving machines and body clearing machines, which are of the horizontal types, and make only one groove and clear only one "land" of the body at a time, instead of completing the grooving or body clearing at one operation, as is done with the larger sizes. The small size bushes which guide and support the drill bodies in the grooving and clearing operations have to have as much clearance for the small drills as for the large ones, and in the small sizes this fixed clearance is so much greater in proportion to the total drill diameter, that it is found impossible to produce work with a sufficiently close approach to symmetry if both grooves or both lands are operated upon at the same time, and symmetry, or the same shape of the two grooves and two lands of the drill, and the symmetrical location of the middle web are of the greatest importance. The small grooving and body clearing machines are extremely ingenious and interesting, and are supplied with micrometer adjustments devised with great skill.

There are several classes and subclasses given to drills in the shop besides the "wire" drills, but for the purposes of this article it is sufficient to class the larger sizes as "straight" and "taper shank" drills. No chuck has yet come into general use which will hold twist drills much over ⅝ inches diameter by a straight shank, if the drill is to be urged to its full capacity for cutting. Hence the taper shank with a holding flat at the end continues in use, and appears likely to do so indefinitely. It is possible to groove the shanks of straight drills so as to hold them in chucks to the breaking point, but this plan has never found general favor, although the taper shank is an expense which it would be well to avoid, if satisfactory all round results could be had without it.

In the manufacture of straight shank drills, the first operation is the inspection and testing of the bars, and the next is the cutting off of the blanks, which is done up to $\frac{17}{32}$-inch diameter on a Bliss-Stiles press, the operator standing up and feeding the rod into the cutting-off

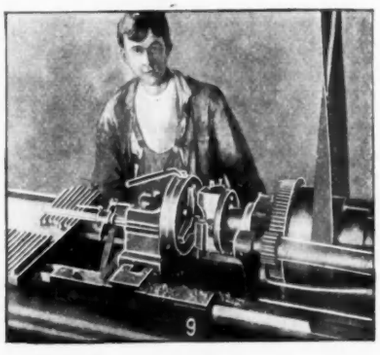

Fig. 9. POINTING STRAIGHT SHANK DRILL BLANKS, SMALL AND MEDIUM SIZES, ON SPECIALIZED ENGINE LATHE.

dies to a stop. Fig. 6 is a view of the cutting off dies. The square punch which is carried by the ram has a semi-circular cut in its face on each of its four sides, $\frac{1}{32}$ inch larger in diameter than the stock it is to cut, and two of these top shearing dies are used, giving eight sizes of cutting off dies between $\frac{5}{64}$ inch and $\frac{17}{32}$ inch.

In Fig. 7, *B* is the bar of stock to be cut, and *S* is the stop gage. The bolster is made with two heavy lugs at the left,

which are tapped for large set screws bearing against the hard steel faced abutment block which is held down with two substantial bolts, and can be adjusted to the right so as to exactly support the cutting off die block, no matter how much its working faces may be reduced by

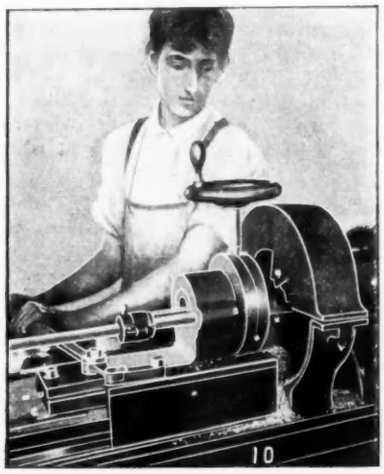

Fig. 10. POINTING LARGER SIZES OF DRILL BLANKS ON SCREW MACHINES, WITH CHIP GUARD OVER REVOLVING CUTTER.

grinding. The set screw in the front of the right hand upright member of the bolster secures the full circle stationary hard steel bush through which the bar *B* is fed to the stop gage. The holes in these bushes are also 1-32 inch larger than the stock to be cut. As the bolster can be moved on the die bed of the press, an adjustable abutment for the punch is provided, and the full circle bushes can be ground on the end and fixed in any position by the set screw in the bolster, there is no difficulty in keeping the punches and dies sharp. Besides being held by the set screw, the full circle bolster bushes are backed up by a short hollow screw, tapped into the bolster at the right hand end, which supports them perfectly against the thrust of the shearing. A strip of felt is let into the punch abutment on the punch side, in such position that the punch always covers the felt; an oil hole leads to this felt chamber, which assures constant lubrication between the punch and its abutment. This press runs 60 revolutions per minute. Those who have had occasion to cut off large numbers of pieces of tool steel to exact length will readily see the value of these details. The work is performed in an extremely satisfactory manner, the blank ends being very nearly square and round. The blanks fall through the opening in the die bed of the press, and are led by a trough into boxes.

Pratt & Whitney cutting-off machines of ordinary construction are used for cutting off stock from 17-32 inch diameter upward.

Although the cutting off in the press is so well done, the blank ends are milled perfectly square in the rig shown in Fig. 8, before the blanks are pointed. This is an old machine, something between a round file carried on a spindle, and a milling machine. The cutter is in the form of a disk mill, with very fine teeth, and is carried on the spindle in a cast-iron, cupped-face plate *A*. The spindle also carries a fly-wheel *B*, and fast and loose pulleys. The blanks which are to have their ends squared are laid in the V-groove fixture *D*, and simply held there by the operator's thumb, while the feed is obtained by the long vertical wooden lever *C*, hinged to the floor and operated by a rope leading over a pulley *P* and down to a treadle on the floor. The lever *C* presses against the outer end of the blank. When the foot pressure is not enough, the operator leans against the wooden lever which stands in front of him. This end-squaring machine is not on the micrometer screw-adjustment order of tools, but it squares blank ends with wonderful rapidity and perfection, and is different from anything else I ever saw. I did not ask the history of this queer tool, but it is evidently not

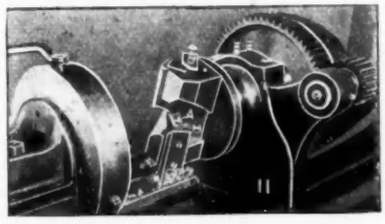

Fig. 11. REVOLVING CUTTER HEAD USED IN FIG. 9.

a make-shift, and it is not easy to see how anything could be better adapted to its purpose. The mill is not lubricated, and was said to be very durable, owing to the yielding feed.

The straight shank drill blanks are pointed at both ends for the "jobber's set" of drills, running from 1-16 inch to ½ inch diameter, the angle of the point being 120 degrees. It is needful that the point end of the blank should have this angle, because the lips of the finished drill are to have it, and because in turning the blanks, they must fit a female or "cup" center; but there is no need for pointing the shank end of straight drills larger than the wire sizes, and, except the "jobber's set," straight shank drills are not pointed at the shank end.

It would seem the more obvious way to chuck the straight shank drill blank in a revolving chuck, and form the 30-degree angular cut with a tool in the tool post. Instead of this regular procedure, the blanks are pointed, as shown in Figs. 9, 10 and 11, using a specialized lathe and screw machine, both with the blank held stationary and cutters revolving.

It is required that the angle of the points should be constant, so that it may be a good fit in the female centers used in the blank turning lathes. This must be exact; near approximations would lead inevitably to slack fits in the centers, and to such wear of them as would make accurate turning impossible. This accuracy of angle could only be obtained by the most careful tool-setting and constant

Fig. 12

"THUMB-NAIL" DRIVING NICK.

gaging, if ordinary lathe tools were used. A special cutter head is therefore secured to the nose of the tool spindle, and this head has angular tool seats, as shown in Fig. 11, and the cutters are so applied to the blanks that if the cutters are ground square across the end, as shown at *A*, the blanks will be given points exactly 30 degrees angle on a side, or 120 degrees solid section angle, with such certainty as to render gaging needless. The cutter seats in the cutter heads are formed at an angle of 30 degrees to a plane at right angles to the spindle axis, and the cutter clearance angle is 2 degrees. In Fig. 9 the tail stock of the lathe is discarded, and the saddle cross-slide is furnished

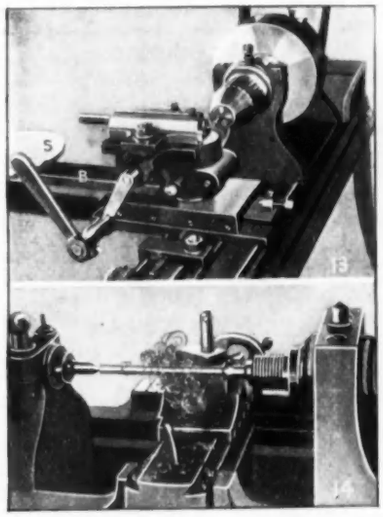

Fig. 13—MACHINE FOR CUTTING THE "THUMB-NAIL" DRIVING NICK IN BLANK ENDS. Fig. 14—TOOL POST REAR.

with a universal chuck to take the blanks in to an adjustable length-stop, and the feed is given by the hand-wheel of the carriage. In Fig. 10 the turret slide of the screw machine has been replaced with a special slide carrying a universal chuck,

as shown, and the chuck itself has been specialized by a vertical jaw-operating pinion shaft carrying a hand-wheel on top, an a chip cover surrounds the cutter head to keep the chips at home. In Fig. 10 the blank stop is clearly shown. This blank pointing cut is made dry, which appears to be contrary to late practice. The cut is made so quickly, and at so little expense for tool-making, as to perhaps not warrant the outlay for lubrication, and an unlubricated cut is, of course, more cleanly.

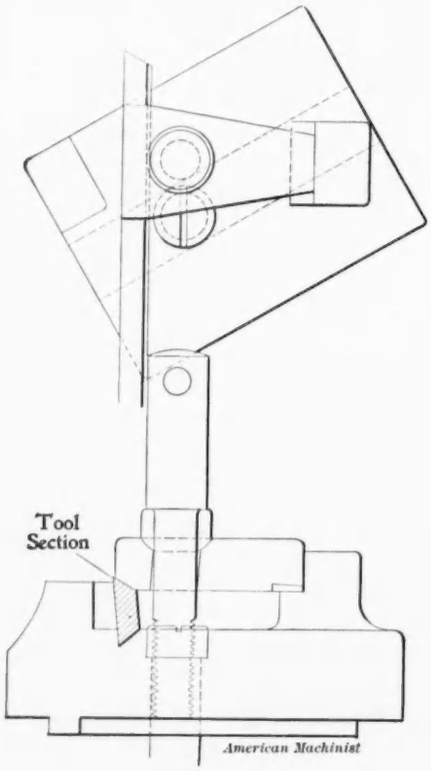

Fig. 15

TOOL-POST PLAN AND SIDE.

For all sizes of drill-blank turning, the points are run in female centers, and the shank ends which go on the live center of the lathe are drilled and countersunk on a Pratt & Whitney centering machine, the drilling and counter-sinking being done at one operation by a combined drilling and countersinking tool, the blank being held stationary in a chuck.

The straight-shank drill blanks are not dogged in the lathe. The "jobber's set" are driven by square live centers, and are taken from the centering machine to the bench, where they are dropped into free holes of suitable depth in a cast-iron block, and have the square center punch driven into the shank end by a hand hammer.

Except the "jobber's set," all the straight shank blanks are driven by a "thumb-nail" cut in the end of the shank, as shown at *C*, Fig. 12. This "thumb-nail" nick is made on a small special milling machine, all as clearly shown in Fig. 13, the blank being held in a V-jawed vise, and fed up to the little mill with the hand-lever.

The taper shank drill blanks, which require a considerable lathe cut, are dogged in turning, and the taper shanks are turned in a taper-attachment lathe.

Figs. 14 and 15 show the peculiar tool-post and tool adopted after many experiments for turning the drill blanks. The tool-holder is in the clamp form, with a single holding screw having a capstan head and bar. The tool is a straight bar of steel of the section shown in Fig. 15. At first these tools were milled to form. They are now forged to section and merely smoothed on the emery wheel. They are hardened and drawn to just change the color. The edge stands better to be drawn to temper than if left full hardness. The general scheme and every detail of the turning practice are the results of many trials. The work is turned dry.

The general system of turning is to use regular engine lathes, with tools and tool posts and driving as shown. Fig. 14 shows the square center drive very plainly. This drive seems wholly inadequate, but serves perfectly well, not giving the slightest trouble in any particular.

(To be continued.)

▲ ▲ ▲

A fly-wheel burst in the mill of the Oliver Iron Company, in Pittsburg, Pa., on December 16th, killing one man, fatally injuring another, breaking the arm of the engineer, and doing considerable damage to the surroundings.

The Mietz & Weiss Oil Engine.

The kerosene engine, for light units of power, is of wide interest and application, and is entitled to respectful consideration. Its advantages need not here be enumerated. The most taking of these particulars are probably readiness, cleanliness and cheapness. The engine shown in the half-tone and in the accompanying sectional view is an interesting member of its class. It is of what is known as the two-cycle type, the explosion and impulse normally occurring at every other stroke, or once for each revolution of the crank shaft, the governing being accomplished by the occasional omission of an explosion, as may be required.

Referring to Fig. 2, the construction and operation of the engine will be readily understood. The cylinder is water jacketed, and the same casting embraces also the closed chamber in which the crank shaft revolves. This chamber constitutes a preliminary air-compression chamber. When the piston is at the extreme left the port *o* is uncovered, and the air rushes in to the partial vacuum, which has been formed in this chamber by the retrograde piston movement. When the piston has advanced to the position shown in the cut, the port *a* is uncovered, and the compressed air rushes from the compression chamber into the cylinder. The air is deflected by the ledge *b*, and shoots along the top of the cylinder to the back, while the previous contents of the cylinder escape at the bottom

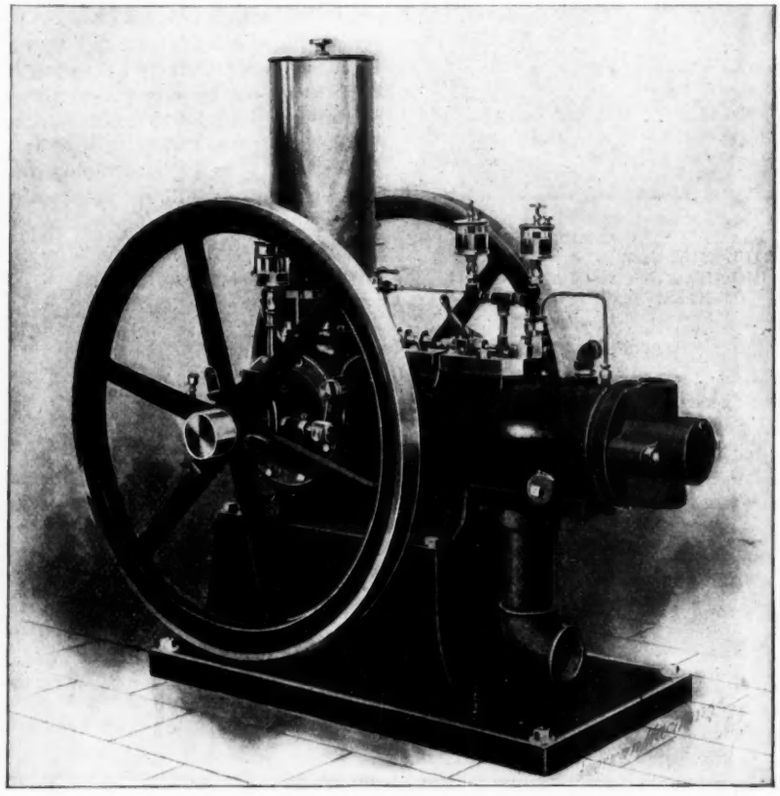

Fig. 1. MIETZ & WEISS OIL ENGINE.

through a^1. As the new charge of air rushes back it meets and mixes with the new charge of oil passing in by the valve *h*. The explosion chamber *D*, at the back end of the cylinder, is provided with a number of ribs *E E*, to increase the vaporizing surface and maintain the temperature, so that after the engine is started it will be self-igniting. The heating for starting is done through the opening *d* at the bottom of the chamber *D*. The plates *E E* remain at a low red heat when the engine is running regularly. As only a minute quantity of oil is admitted for each charge, it collects in a drop at the end of nipple *H*, and is blown in the form of spray into the explosion chamber by the upper end there is jointed a horizontal rod, terminating at the left in the notched end, as shown. The lower half of this end, c^5, is a tempered steel plate with a sharp edge and a beveled end corresponding to the end of the hinged figure, f^2, on the end of the sliding plunger *f*. The rod c^1 is threaded, and has on it the hexagon nut c^2, one flat side of which, as the rod reciprocates, travels up and down the inclined plane c^3. When the engine is running at normal speed, or below that, the steel edge c^5 will always engage the end f^3 of the hinged finger, f^2, and a charge of oil will be delivered. When, however, the engine runs too fast, the nut c^2, in ascending the inclined plate, will be carried so high by its momentum that c^5 will land on top of f^3 and ride along without causing any movement of the plunger, and the charge of oil will be omitted. If the edges of c^5 and f^3 so nearly coincide that there is not enough bearing for the thrust the hinge of f^2 allows the finger to rise until the entire end is engaged. The details of the plunger *f*, etc., which are provided for adjustment or for smooth action, need not here be described in detail. The speed of running may be changed by screwing the nut c^2 along on the rod, bringing some other face to bear on the inclined plane. The oil reservoir is the vertical cylinder seen in the halftone, the oil passing down the passage g^1 by gravity.

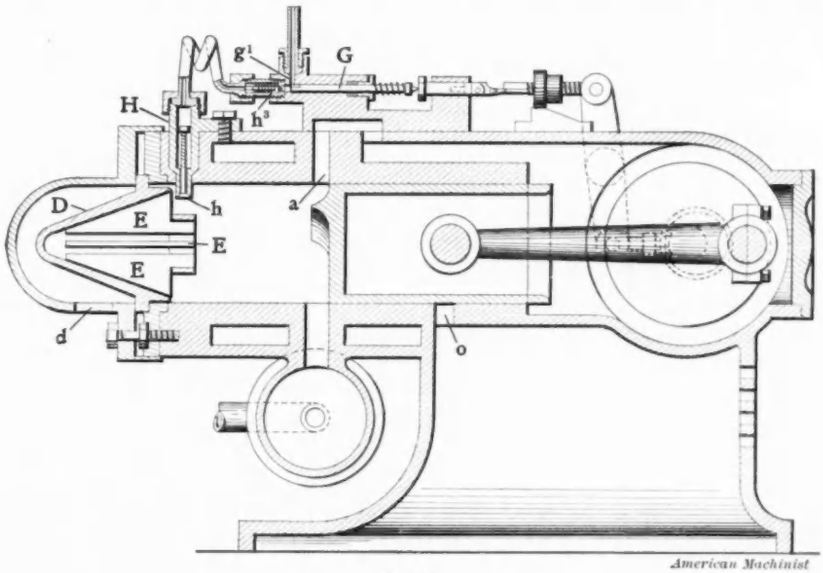

Fig. 2

SECTION OF OIL ENGINE.

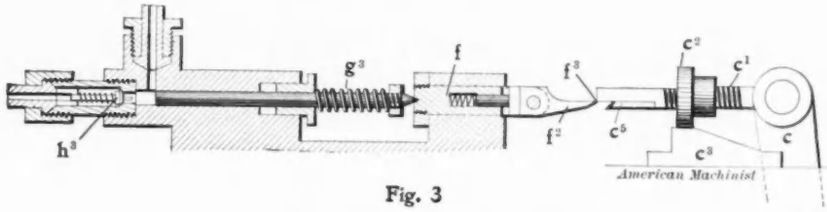

Fig. 3

THE GOVERNING DEVICE.

the inrushing charge of air, leaving none to be carbonized on the nipple. The valve *h* prevents any of the explosive mixture from passing upward into the oil chamber.

The mode of feeding the oil and of governing the engine will be understood upon reference to Fig. 3. The oil descends by the passage g^1; the portion of oil which lies in the plunger chamber to the left of this passage is forced by the plunger, on its extreme movement to the left, past the valve h^3 and into the delivery pipe. The plunger is held normally to the right by the spring g^3, and is moved to the left to force in a charge of oil by the action of the vertical vibrating lever *c*. This lever runs constantly, being driven by an eccentric on the crank shaft. At

This engine is run at a high speed, is almost absolutely noiseless and governs very closely, so that many of the engines are used for small electric-light plants. The smaller sizes are practically as economical as the larger. The cost of oil, with kerosene at the usual figures, is given as one cent per horse-power hour. Sixteen candle-power lamps are run at a cost of one-tenth of a cent per hour each. The engine is built by Mietz & Weiss, 128-132 Mott street, New York City.

▲ ▲ ▲

Promoting Competition in Railroad Shops.*

A number of times when the subject of cost of repairs has been discussed in the club, there has been criticism of an unfavorable character of the management of railway machine shops. This, I believe to be thoroughly unjust. The main locomotive repair shops of to-day are, in every sense of the word, manufacturing establishments, and manufacturing usually on a very large scale. The day is rapidly passing when such shops can be treated simply in the light of repair shops. The reason of this is due, primarily, to the fact that the office of superintendent of motive power has been established, and the authority of the master mechanic to form standards for his division has been abolished. The roads have thus been able to establish a standard which extends over the entire system, and as rapidly as the old equipment is placed in disuse, new equipment is purchased which conforms to the general standard. The result is that those parts of the locomotive which are subject to rapid wear and frequent replacement are manufactured at one point. This is being carried still further and, on a number of roads, the work of general overhauling is being concentrated at one shop. . . .

The master mechanic's duties are so numerous that he generally has little opportunity to leave his factory; he is inclined to carry on and employ methods with which he is most familiar; he is not placed in competition with any other factory, and while generally he operates on quite an economical basis, he has not a general knowledge of the cost of the various articles he manufactures, as compared with the cost of what would be, in outside business, his competitors, and so he is not spurred on by competition, as he would be in other lines of manufacture. As a consequence of not having the knowledge of the costs of other manufacturers he is not liable to be over sanguine as to his ability to reduce the cost of his own manufacture.

Each railway machine shop is manufacturing about the same class of goods as every other one, and if there were an opportunity presented of showing to each other the cost of the different details, then

* From a paper by J. W. Gardner, read before the Western Railway Club.

the party responsible for the cost, seeing that one of his competitors was able to manufacture an article for very much less than he was doing it himself, would familiarize himself with his competitor's methods. There is, owing to the good feeling that exists between all of the parties operating railway machine shops, no difficulty experienced in learning what means other shops are using for accomplishing desired ends; it is entirely different in the regular manufacture, where every advantage one company has in manufacturing over the other is jealously guarded. There are a great many instances with which we are all familiar, where some one operation has been greatly reduced by a certain road. This information has been noised abroad, and has led to a great reduction by other roads, in the cost of manufacture. As an instance of this kind, I need only mention the rapidity with which the flue work is handled by the different roads now, in comparison with a few years ago. . . .

A communication received a few days ago and relating to turning the tires of coach wheels on a certain road, gave the record as 1,100 pairs of tires in 200 working days, each day of eight hours duration. Another communication gave the average time of turning locomotive drivers, irrespective of size and condition, as four hours per pair. This time may not be excessively rapid and possibly is being exceeded by a great many people, but those who exceed this time have the satisfaction of knowing that their cost of turning tires is at a minimum, and those who are not doing this work as rapidly, have an opportunity of inquiring about the methods and machines upon which this work is being done. The rapidity with which work can be done is not always a just criterion as to its cost; the quality of the work must also be taken into consideration.

I also have an instance of the boring of tires by one of the roads, which has made a very economical record. The superintendent of motive power in conversation with the superintendent of motive power of another road, mentioned the length of time, also the cost per piece, of boring tires on his road; the cost was given as 30 cents. The superintendent of motive power to whom he told this was rather incredulous, and, in company with his assistant, called upon the first road, and it was demonstrated to him actually what this cost was. He returned to his shop and found that his equipment was exactly the same as his competitor's, and that it was merely a question of feed and speed to make it possible for him to do the work with the same dispatch and at the same low cost.

The last few years have shown wonderful results in the development of the art of the steel maker, but this has not been taken advantage of to the extent that it should be. Machines are not operated up to the limit in feet per minute, or feed per inch, that the steel of to-day is capable of standing. With the development of steel has come the development of machine tools of sufficient strength to carry the cutting capabilities of the steel up to its limit.

There is another point that I might touch on here, and that is the specifications for machine tools. The specifications are usually sent out by the purchasing department, requesting a machine, say a planer of certain width between the housings, certain hight it will plane under the cross rail, and certain length of bed. The different manufacturers make offer of their tools on these specifications, but there is no examination as to the detail on which the different manufacturers bid. When purchasing a locomotive, all of the essentials are specified, but when purchasing a machine tool which is, in comparison to price, as large a source of expense to operate as the locomotive, the details go unheeded. It is just as much a necessity to make comparison in the strength and power of tools as it is in the strength and power of locomotives, in order to get at the minimum of cost of repairs. It is not always the most expensive tool that effects the largest amount of saving.

A year or two ago I had a conversation with the superintendent of motive power of one of the large systems, relative to the reduction of expense of his brass work. I, in company with the assistant superintendent of motive power, called upon a large brass manufacturing concern, and through the courtesy of the superintendent their method of manufacture was thoroughly explained. The railroad then purchased a tool for doing its brass work, the tool cost not to exceed $400 or $500. About a year after the tool had been installed, I called upon the superintendent of motive power in company with a gentleman from one of the foreign roads. We happened to stop in front of this particular machine, which at that time was idle, and it was explained that now there was hardly sufficient work to keep the machine going continuously, and with this small tool it had been possible to effect a saving so great as to be almost incredible. This saving was the result of two things: First, the establishment of a different system for doing the work, and, second, the employment of a very ingenious tool maker to operate the tool.

To sum up the question of machine tools, I believe that the first thing to do is to get a statement showing the costs of the various articles manufactured by the different railway machine shops, then by comparing the time used by one shop to do certain work with the time required in another shop to do similar work, the tendency will be toward a uniform minimum first cost of production. The cost should not be stated upon a basis of dollars and cents, but upon the basis of hours of labor that are required to produce certain results.

When this information is obtained, and the superintendent of motive power sees that it is on account of imperfection of his machine shop equipment that his costs are excessive, he will then be anxious for an appropriation for the betterment of his factory. Competition has been the great teacher in the standard factories, and it has been by watching every detail of the cost of production that goods are now manufactured as cheaply as they are. The same method applied to the railway machine shop will be productive of the same results.

▲ ▲ ▲

The Alternating Current.

BY LAWFORD H. FRY.

There are many who are well acquainted with the ways of direct currents of electricity, but to whom the matter of an alternating current is a good deal of a mystery, mainly because the subject is usually presented in a mathematical form.

Now the mathematics are not an absolute necessity of the subject, but are useful as enabling the matter to be accurately set forth, and easily handled by those practiced in mathematics.

On behalf, however, of those who are not so well versed in this science, an attempt is made here to make clear the occurrences in a circuit carrying an alternating current of electricity; and this without indulging in the complicated formulæ, with which an expositon of the alternating current commonly bristles.

The difference between alternating and continuous currents of electricity is that indicated by the names, when we examine into the properties of a direct or continuous current, we consider the case of a current of electricity flowing steadily in the one direction. With an alternating current we have to consider the case of a current flowing first in one direction and then in the other through the circuit, the change not being made suddenly but by a gradual increase and decrease in each direction.

That which causes the relations between electro-motive force and current to differ in the case of the alternating current from those with which we are familiar in the case of the continuous current, is the action of the lines of force produced by the current.

With a steady current a certain number of lines of force encircle the conductor, and these once in existence have no influence on the circuit; but with any change in the current strength there is a corresponding change in the number of the lines of force surrounding the conductor.

The effect of an increase in the number of lines of force surrounding the conductor is similar to that which would be produced if we were to imagine the number of lines of force, which are added, moved from a position remote from the conductor to encircle the conductor; and the

effect of a decrease in the number of lines is the same as that which would be produced if the lines be imagined to be removed from surrounding the conductor to a distance from it. That is the effect is as though on their appearance and disappearance the lines of force cut through the conductor, an electro-motive force being set up in the conductor.

This induced E. M. F. has such a direction that it opposes the change of current which produces it.

Now to apply this to the case of an alternating current where the current is continuously altering its strength and direction.

Consider the simplest possible form of alternating current generator, viz., a coil of wire rotating as shown in Fig. 1 in a magnetic field of uniform strength, where the lines of force are equally distributed and run in straight lines from pole to pole at right angles to the axis of rotation of the coil.

Fig. 1

Fig. 2

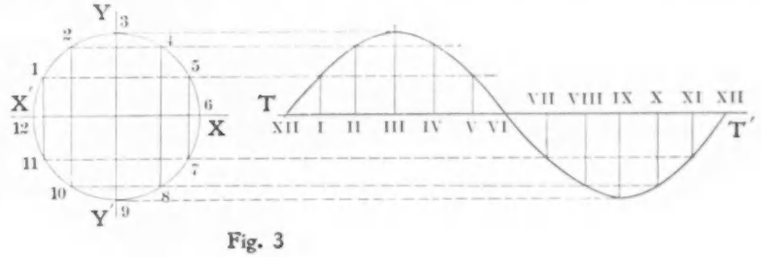

Fig. 3

During every rotation of such a coil the E. M. F. generated will go through the folowing cycle of changes. It will rise from zero to its maximum value then decrease again to zero, then changing its direction it will rise from zero to its maximum value and once more fall to zero. Just how these changes follow one another we shall see later on. For the present let us see what the general effect of the self-induction of the circuit will have on the relations between E. M. F. and current.

At the turn of the current the extra current induced by the disapearance of the lines of force tends to strengthen the waning current and keep it flowing after the E. M. F. has disappeared; and after the turn the back E. M. F. produced by the growing number of the lines of force tends to retard the growing current. Thus we see that the production and annihilation of the lines of force make the current lag behind the E. M. F. This will perhaps be made clearer by the following method of expression.

The current cannot attain its full strength till the full number of lines of force, which it can produce, are present and their production is a matter of time; likewise the current cannot completely cease till all the lines of force are gone, and their disappearance is also a matter of time. Thus the current does not attain its maximum and zero values at the same time as the electromotive force does, being somewhat retarded. This behavior of the lines of force, by which a retardation of the current with regard to the potential is known as the '*reactance*' of the circuit.

The interval between the maximum values of the E. M. F. and current will depend on the magnitude of the reactance of the circuit.

The magnitude of the reactance depends in its turn on the arrangement of the circuit.

If this consists of a single straight conductor each line of force will on its appearance and disappearance only cut the conductor once, and the back E. M. F. and the reactance will be small. If on the other hand the circuit contain a solenoid the lines of force due to each turn of wire, will on appearing and disappearing cut a large number of other turns so that the reactance will be large. If an iron core be introduced into the solenoid, thus enabling it to produce a great number of lines of force, the reactance will be very large, and may be so great that the interval between the current and potential maxima is too large to allow any large amount of energy to be transmitted through the circuit. In this case the energy which would be transmitted is expended in producing lines of force only to be given up again as these disappear.

We will now leave this subject of reactance to deal with it in a more definite fashion, when we shall have, as promised above, examined more fully into the manner of the changes in the electromotive force and current in an alternating system. Since the principles involved are identical we will consider the changes in the simple case of Fig. 1, rather than in the more complicated case of a practical alternating current dynamo.

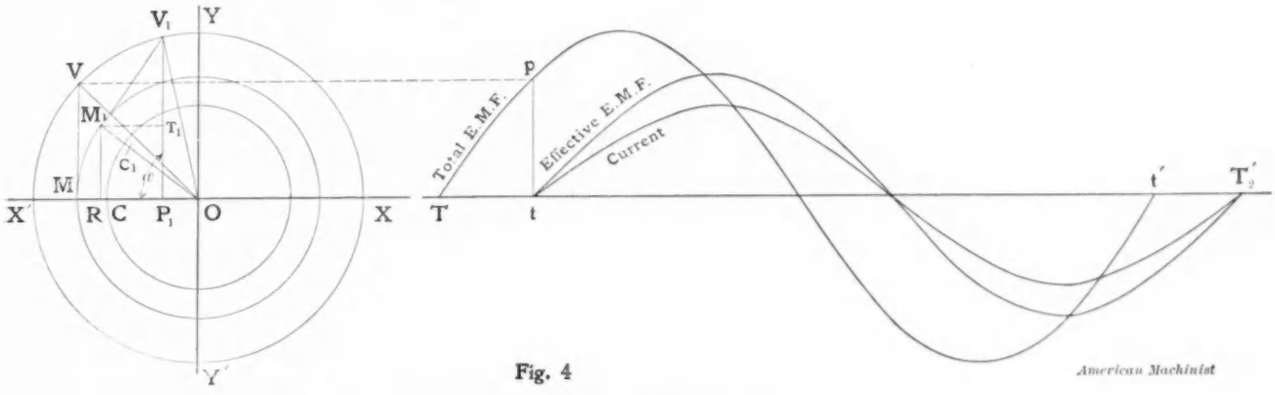

Fig. 4

American Machinist

THE ALTERNATING CURRENT.

According to the fundamental rule the E. M. F. in the coil at any instant will be directly proportional to the speed at which the coil is moving across the magnetic field at that instant, the lines of force being evenly distributed over the field. Hence a representation of the changes in this speed will be also a representation of the changes of the E. M. F. Consider for our purpose the speed of the extremity of the coil. This velocity may be represented in magnitude and direction by a line of constant length at right angles to the plane of the coil. If for instance *C O C′*, Fig. 2, represent a position of the coil, we may represent its velocity by *O V*. The more natural position for the line would

be $C V'$; but it will be more convenient for our purpose and equally correct if we move the line parallel to itself so that it passes through O, the center of the coil. Draw $V N$ and $V M$ perpendicular to $O V$ and $O X$ respectively.

Now we may consider the velocity represented by $O V$ as consisting of two velocities, one in the direction of the lines of force, the other perpendicularly across them. $V N$ and $V M$ will represent these velocities; $V M$ representing the velocity across the magnetic field with whose change we are concerned. To obtain the representation of this change, let $Y X Y' X'$, Fig. 3, be the circle described by V as the coil revolves. Let the line $T T'$ represent the time of one revolution of the coil. Divide the circle into twelve equal parts at the points 1, 2, 3 . . . . 11, 12. Divide $T T'$ into twelve equal parts at the points I, II, III . . . . XI, XII. Then since $T T'$ represents the time of a revolution, the points I, II, III, etc., will represent the instants at which V, the revolving end of the line of $O V$ is in the positions 1, 2, 3, etc., on the circle. Now at I, II, III, etc., erect perpendiculars which shall be proportional to the speed of the coil across the magnetic field at the instants corresponding to the points.

This is very simply done by drawing vertical lines through I, II, III, etc., and horizontal lines through 1, 2, 3, etc. Join the points where the lines through 1 and I, 2 and II, 3 and III, etc., meet, by a curve. This curve will represent the changes in the E. M. F. If we desire to know the E. M. F. in the coil at any instant, we erect, from the point on the time line corresponding to this instant, a perpendicular to meet the curve. The length of this perpendicular will be the required E. M. F.

If the curve cannot be drawn with sufficient accuracy from the twelve points we have used we may divide the circle and line $T T'$ into as many parts as we please, and by the method used above draw the curve with any required degree of accuracy. As a matter of fact we do not need a strictly accurate curve since its chief use is merely to serve as a picture of the changes in the E. M. F. We can picture the changes in the current by means of a similar curve. We saw previously that the maximum current and maximum potential would not occur together. Let us now see how this will fit in in the curves. How do the two curves lie when drawn in the same figure?

We may consider the reactance as composed of two parts, that which must be overcome before the current can be started, and that which must be overcome before the current can attain its full strength. To produce the E. M. F. necessary to overcome the first of these two parts the coil must turn through an angle; let this angle be α and let the time required be t. Introduce this into the diagram, Fig. 4. Then $V M$ and $p t$ will be proportional to the E. M. F.

Now, instead of considering V, the revolving point, the perpendicular from which on $O X$ gives the instantaneous E. M. F., as the end of the straight line $O V$, consider it as the end of the bent line $O M V$. The perpendicular from V will still give the total E. M. F. in the coil at any instant, and the perpendicular from the revolving point M on to the $O X$ will give the E. M. F. effective in driving the current at any instant. For take another position of the bent line as $O M_1 V_1$. Draw $V_1 P_1$ and $M_1 R_1$ at right angles to $O X$, and $M_1 T_1$ at right angles to $V_1 P_1$. Then $V_1 P_1$ will represent the total E. M. F. in the coil at the instant under consideration. This line is divided into two parts at T_1, and these two parts will represent the two components of the total E. M. F. $V_1 T_1$ will represent the E. M. F. overcoming the reactance, and $T_1 P_1$ the E. M. F. effective in driving the current. That this is so we may see by the following consideration:

$T_1 P_1$ is equal to $M_1 R_1$, the perpendicular from the revolving point M on the line $O X$. This perpendicular comes into existence at the same instant as the current does, at the time t after the zero position of the coil is passed, and increases and decreases after the same law as the current does. Consequently the E. M. F. represented by $T_1 P_1$ is directly proportional to the current, that is, this E. M. F. stands in the same relationship to the current as any ordinary steady E. M. F. does to the continuous current driven by it. And obviously the difference between this and the total E. M. F., i. e., the E. M. F. represented by $V_1 T_1$ will be the E. M. F. overcoming the reactance.

Let $O C$ be the measure of the maximum current in the same scale as that in which $O V$ is the measure of the maximum E. M. F.

Draw the curves after the manner of Fig. 3 for the revolving points V, C and M. Since the effective E. M. F. and current are zero t secs. after total E. M. F. is zero, their curves will cut the time line in the point t. Thus, as we agreed ought to be the case, the current maximum occurs later than the potential maximum. The value of the curve from the point M is that it is this E. M. F. which, taken in conjunction with the current, gives the work done in the circuit.

In practical work we do not want to follow the variations of potential and current as given by these curves, but we want their average values without regard to direction. If we use non-polarised instruments—as, for instance, the hot wire instruments, which are sufficiently slow of movement not to be affected much by the very rapid changes—we can read directly these required average values.

We are not able to measure the E. M. F. represented by the curve from the point M, save by indirect means. Let c be the average value of the current in amperes, e be the average value of the total E. M. F. in volts, and e' the average value of the effective E. M. F. in volts.

The work done in the circuit in watts will be $e' \times c$. We can measure this by means of a wattmeter. If we also measure c by means of an ammeter, we can then, by a simple process of division, ascertain the value of e'. If we wish to determine α, the angle by which the line tracing the E. M. F. curve precedes the line tracing the current curve, otherwise known as the angle of retardation of the current, we measure e, and determine e' in the manner above described. Now e and e', the average values of the total and effective E. M. Fs. will be in the same ratio to each other as the maximum values of these E. M. Fs.—i. e., in the ratio of $O V$ to $O M$.

But $O V M$ is a right-angled triangle; hence, if we determine the ratio of $O V$ to $V M$, we determine the angle $V O M$ included by these two sides.

Of course in an alternating current dynamo we shall not have the simplicity of the single rotating coil, but the principle will remain the same, and the same cycle of changes will take place, not once in a revolution, but once every time a coil changes from one pole to another.

Now having examined the mechanism, so to speak, of the alternating current, we may in conclusion just note that the justification of the use of alternating in place of direct current is the ease and economy with which we can transform from high to low potential, and vice versa. Since the loss of energy in the transmission of power and the weight of the conductor, two items which it is to our interest to keep down, vary inversely as the potential at which the power is transmitted, it will in the case of long-distance transmission, be advantageous to transmit the power by means of a current at a high potential, and to transform this into a potential low enough to be used with safety at a point near the place of consumption.

The alternating current affords the simplest method of doing this. Hence the use of alternating current in long-distance power transmission installations—as, for instance, that at Niagara Falls.

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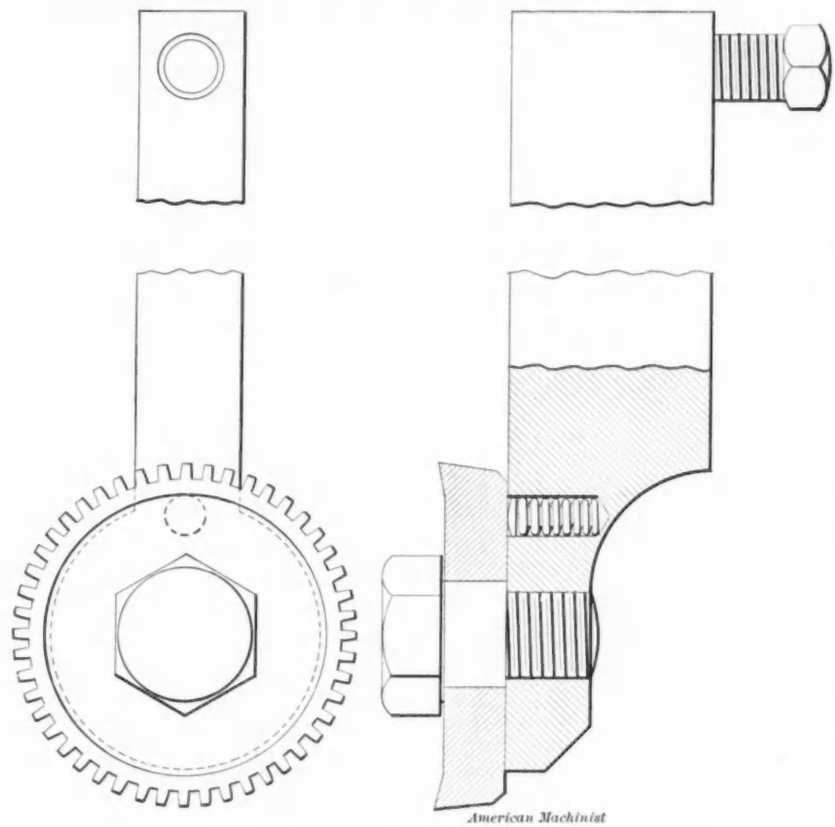
Planing Racks Without Spacing.

It may doubtless be regarded as somewhat of a coincidence that while we were preparing the matter regarding the Fellows method of gear cutting, recently described in our columns, the tool herewith illustrated for planing rack teeth upon an ordinary planer was brought to our notice. The sketch, Figs. 1 and 2, shows a tool which was first used more than two years ago, and has been used frequently since, so that it has cut a large number of racks. The tool as shown represents also the entire apparatus employed

either for spacing or cutting the teeth. It is used precisely as an ordinary planer tool is used, and is fed across the work, or over the length of the rack or batch of racks to be cut, doing its own spacing as it goes along. The feed may be fast or slow as the cutting may allow, and has nothing to do with the pitch of the teeth. The round, toothed steel cutter is mounted to turn freely on the shoulder screw, which is tapped into the face of the tool stock, and then a helical spring and plunger are provided to give a certain frictional resistance to the cutter. At the upper end of the holder a set-screw is set at right angles to the body of the holder, and when the tool is fastened in place, the screw is adjusted so that the tool will have only a very slight lift. The feed of the planer must be arranged to occur on the return stroke.



TOOL FOR PLANING RACKS.

The rack or racks to be cut being securely fastened across the planer platen with the ends in line, the tool is set so that the center of the cutter comes over the first end of the rack, and it is fed down until the full depth of the tooth is reached. This may be done by using the vertical screw of the tool holder as a micrometer. When the full depth of the tooth is reached, three or four teeth of the round cutter will be cutting at once. The cross feed is then thrown in, and the cutter will roll as it feeds along, and the teeth will be properly spaced and shaped without further care. When we saw the tool in use, it was upon a small, weak planer, and the feed was only about 100 to the inch, and the cutting speed was quite high. The face of the cutter is made dishing, so that the teeth have a good cutting angle, and the cutter is also made with the necessary back clearance to the teeth. The cutter seen in operation was 24 diametral pitch. Both coarser and finer pitches have been cut, and racks have been cut a foot long, with fine pitch, such as are used in exploding batteries for miners' use. The tool is made by L. T. Weiss, 286-290 Graham street, Brooklyn, N. Y.

Experiments on Melting Wrought Iron.

The expense of melting wrought iron in the Nobel furnace is so great that the firm with which the writer was connected experimented to find some cheaper method. The idea was that if we wished to gain business we must outdo our rivals either in quality or in price. As to quality, there did not seem to be much room for improvement, and in regard to price, well, we were using the same process as they were, and if we cut, why it stood to reason they could meet us, and probably go further, as they were old and well established and had got the thing down to a fine point, while we had only just commenced and had not finished experimenting. The only thing, then, was to produce cheaper, and at once we turned our attention to our furnaces. Were they perfection? It did not seem like it. It cost us a little over ½ cent per pound of metal for crucibles alone, even when buying them by the car load, while as to repairs, we never did know what they amounted to per pound, but they were excessively high, as the furnaces had to be partially rebridged every three days. (The writer is aware that the above figures on crucibles are higher than has so far been published. Ostberg claims that six heats can be taken out of one crucible. Howe says only three. While the maximum is three heats, the average is only two and a half. I have known instances where, out of a whole car load of crucibles, not one of them stood three heats. This refers to pots holding only 100 pounds of metal. In the case of crucibles holding 200 pounds, I never knew one instance, in the experience of two different firms, where more than two heats had been taken from a pot.)

Of course, we knew that any furnace used for producing the high temperature necessary for mitis would need frequent repairs, and be costly on that account. We had already experimented on the "coke hole," using natural draught, and the results obtained were in some respects encouraging, in comparison with the Nobel furnace. We had obtained two heats a day from each furnace, the first heat taking five hours to melt and the second three and a half, and we had obtained from six to eight heats from each crucible. But, there was a but; we had abandoned it because of the trouble the furnace caused by not working uniformly, as it was very susceptible to atmospheric conditions, such as direction of wind, humidity, etc., while the labor was so excessively exhausting that it was difficult to retain our help. We had an idea that we could melt with illuminating gas, and seeing a description by a noted writer on foundry practice, of a gas furnace adapted to melting steel, we resolved to give it a trial, and accordingly sent for one. In due time the furnace with blower arrived and we set it up according to our directions, which were full and complete. The furnace was circular in form. The burner was introduced into the furnace near the mouth, and it was placed tangentially and so adjusted that the flame should strike the top of the crucible. Owing to the peculiar method of introducing the burner into the furnace, the flame formed a whirlpool, in the center of which was the crucible, which was consequently enwrapped by the flame. The products of combustion were carried off by a flue underneath the crucible support.

The performance of this furnace, according to entries made in my note book at the time, was: "The burner ran through seven feet of gas per minute on being lighted without blast. On putting on the blast this was first reduced to 5½ feet, and finally to 3 feet per minute as the furnace became hot. The pressure of blast was 16 ounces, and we calculated that the blower absorbed three horse

power. After running two and a half hours the furnace had only attained a bright red heat, probably a little over 2,000 degrees Fahr., and seemed to have reached its maximum. It was, therefore, shut down, as we believed it would not develop enough heat to melt such refractory materials as are used in making mitis castings.

After a careful consideration of the performance of the furnace, we reached the conclusion that, in order to obtain the proper temperature, it must be supplied with hot blast, and possibly hot fuel also. This would necessitate the construction of regenerators, which it would never pay to build on a small scale. Consequently, we would have an imitation of the Siemens-Martin pot furnace, using, however, a more expensive fuel, as illuminating gas is more expensive than producer gas. This experiment made it clear to us that gas could not compete on equal terms with either solid fuel or petroleum (these equal terms being absence of regenerators). With solid fuel, using natural draught, both fuel and air were heated to incandescence, before reaching the zone of fusion. The air was heated by passing through the thick bed of fuel on the grate bars. It was necessary to renew this bed every forty-five minutes, by picking the dead coke from beneath and poking down fresh hot coke from above. The coke so picked out was not entirely burnt, but extinguished, and we had to sacrifice its heat in order to procure the necessary temperature around the crucible. The fuel is heated by being piled upon the top of the crucible, when it contributes to the final result only by intercepting the waste heat, so that when poked down to the point of utility around the sides and bottom of the crucible, it will not chill the same as it would when cold. Theoretically, this is not good practice, as this reserve fuel wastes heat, by converting the escaping carbonic acid gas to carbonic oxide, but practically we could not melt without so doing. Exactly the same thing occurred with petroleum. We did, and were able to sacrifice a portion of the fuel to arrive at a desired result. With gas we could not do this, at least with the burner supplied with the furnace, as this demanded a certain amount of air to a given quantity of gas, and as the air was cold, it absorbed the heat necessary to enable it to be burnt from that part of the furnace where it was needed the most.

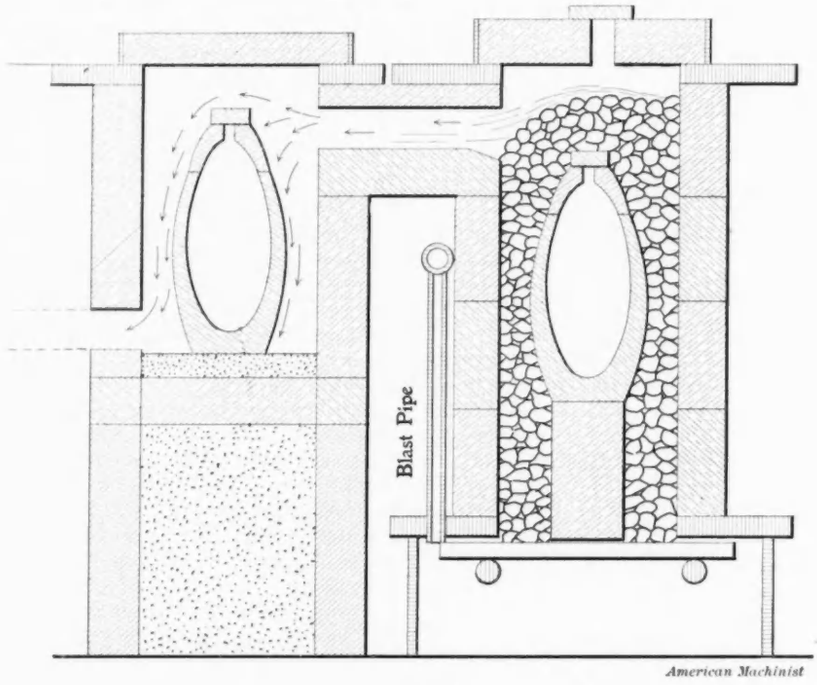


Fig. 1

SECTION OF IMPROVED STRAIGHT-SHAFT FURNACE.

Probably the efficiency of this furnace would be increased by introducing the burner at the base of furnace and taking the products of combustion from the top, also by withdrawing the burner about 12 inches from the furnace, instead of introducing it immediately through the casing, as this would give a chance for the gas and air to become more intimately mixed before being burnt.

Our next experiment was with oil instead of gas, introduced into a circular furnace in the same manner.

The burner was supplied with compressed air, the air issuing through a circular hole through the center of the burner; the oil from an annular opening around the hole. The oil was thus sprayed into the furnace. In order to give satisfactory results, such a flame must have plenty of room. On the scale we tried, it was a failure, though the heat was greater than given by gas.

In Fig. 1 is shown, in section, the furnace we next tried. It was an improved coke hole, and was supplied with blast at a pressure of 16 ounces. It will be noticed that the flue is enlarged to form a heating chamber. It was operated in the same manner as the Nobel furnace, but was only large enough to accommodate two pots, instead of four. One pot was placed in the melting hole and another in the flue. The results obtained were in some respects remarkable, as they showed that it is possible to build a solid fuel furnace that will melt faster than either oil or producer gas. Starting up cold, we melted 100 pounds of wrought iron in 3½ hours, the time of the oil furnace being 6 hours. After the pot was drawn, it was replaced by the hot one from the flue. This was ready for pouring in 1¾ hours.

Several defects showed themselves, of course. The chamber in the flue did not save as much heat as we expected, the cause of which was discovered and remedied. As the products of combustion consisted largely of carbonic oxide, this gas passed away without flaming, because the chamber being sealed there was no oxygen present therein. We therefore turned in a portion of the blast; the carbonic oxide was changed into carbonic acid in the chamber, the crucible and contents having the benefit of the heat evolved thereby. In this way we saved the atom of carbon we had been losing from the reserve fuel on top of crucible in the melting hole.

To obtain the best results from this furnace the following rules must be observed: The lining of the furnace must be kept in first class condition; the fuel must be poked down often and thoroughly, and the pressure of blast must be kept constant and strong. Given these things this furnace will give good and economical service.

Although the results obtained with this furnace were decidedly encouraging, still we were not satisfied. It cost too much in horse power to run the blower. We estimated this at three horse. We therefore tried another scheme, building another furnace similar to this one and connecting the two to a large low pressure blower.

We thus supplied them with a large quantity of air at a low velocity, and then our troubles began. The fires burned all right on top and developed plenty of heat, but underneath the coke was chilled to such a hight above the grate bars that we could not keep the bottom of the crucible hot, and the metal would be melted on top and solid in the bottom. It was the same old trouble, cold blast. The whole thing was a complete failure, and the firm, becoming disgusted, abandoned the experiments and returned to the original oil furnace, and sought to solve

the problem on other lines, which they eventually accomplished by making castings in green instead of dry sand, thus saving the expense of ovens, flasks, and labor of handling the molds, not to mention the advantage of being able to accommodate customers at short notice.

But the writer firmly believes that a coke furnace can be built that will beat the Nobel, both in time of melting, economy of crucibles, and repairs, and some time in the future hopes to return to the subject again. K. K.

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Letters from Practical Men.

The Fellows Abnormal Gears.

Editor American Machinist:

The Fellows gear shaper described in your issue of December 9th, strikes me as the most interesting contribution to gearology since the appearance of the Bilgram bevel gear cutter, to which it is, in fact, first cousin.

I must say, however, that I can scarcely agree with your explanation of those abnormal gears. Imagine the correct gear of your Fig. 14 in the middle of the set, with the large one on one side and the small one on the other, and see what your explanation leads to. The normal gear would then drive one larger and one smaller than itself at turn per turn, to do which all pitch circles must be of equal diameter. If you will take the pitch diameter of the normal gear in a pair of dividers and apply it to the other gears, you will find it to come near the roots of the large one and near the outside of the small one. Now, the root diameter of the large one does not reach the pitch line of the normal, while the outsides of the teeth of the small one go inside the pitch line of the normal. How is this thus, or is it thus? It looks to me as though the action of these gears is not correct at all, but as though they hobbled around in an any-way-to-get-there fashion, as teeth whittled out with a jack-knife might be made to do.

C. K. ADAMS.

[Our correspondent's difficulties are perhaps due, in some measure, to the brevity of our account of the phenomena of excessive addendum and dedendum, and to the fact that our Fig. 15, in order to show these things briefly, assumed a fixed pitch line.

The pitch circles of a pair of gears in action, are those circles which, rolling upon one another, would give the same velocity ratio as that of the gears. In epicycloidal gears they are more than this, being the base circles on which the generating circles are rolled to produce the tooth profiles. The pitch circles of epicycloidal gears are thus fixed for any gear. In involute gears, however, they have no connection with the generation of the profiles, and exist only as rolling circles. It is well known that involute gears may be drawn apart without affecting the correct action of the teeth. If Mr. Adams will imagine two 3-inch involute gears in close mesh, with the centers 6 inches apart, the circles rolling upon one another would be, of course, 3 inches diameter; but if the gears be drawn apart, say, ⅛ inch, the 3-inch circles would not touch one another, and could no longer be considered as the pitch circles, but the circles which must now be so considered are 3⅛ inches diameter. Similarly, a 3-inch gear may be in close mesh with another on one side, and in loose mesh with a third on the other side. With respect to the second gear, the pitch diameter of the first is 3 inches, but with respect to the third it is 3⅛ inches. In other words, the pitch circles of involute gears are not, as with epicycloidal gears, of fixed diameter, but may vary in the same gear according to adjustment, and the same gear may have at the same time two or more pitch circles, each one determined by a mating gear.

A similar condition of things exists

EXTENDED GEAR TEETH.

here. With the normal gear in the middle, its pitch circle, with respect to the large one, is half-way between the centers, and with respect to the small one, halfway between those centers. In other words, it must be considered as having two pitch circles at the same time. The large gear of Mr. Fellows' set may, in fact, be considered as one which has been drawn apart from its mate in the manner described, and then had its teeth lengthened and thickened to fill. This is illustrated in the sketch, in which the full lines represent the teeth of two involute gears which have been drawn apart. The pitch circles are now half-way between the centers, being represented by arcs *a b*, *c d*. In this position there is a good deal of back lash, and if the upper gear be imagined to have its teeth extended to the dotted lines, it will become precisely what we see in the large Fellows abnormal gear, the pitch circles remaining after the addition where they were before, and being near the points of the normal teeth, but near the roots of the abnormals.—Ed.]

▲ ▲ ▲

The Almond Engine.

Editor American Machinist:

Mr. T. R. Almond seems to be very good natured, and evidently does not expect his very novel engine to be the topic of discussion among mechanics without having some hard questions asked him.

I believe that after a man has taken up a principle and applied it, has studied it thoroughly and has embodied it in a successfully working machine, he is pretty likely to know considerable about it that he does not tell unless he is asked. I believe Mr. Almond could greatly interest the readers of the "American Machinist," by showing us how the forces distribute themselves during a single revolution of the engine.

Mr. Fulton has shown very clearly that centrifugal force should not be a disturbing factor. Mr. Chas. T. Porter once said, in telling why an engine "turns over," that "the crank pin usually moves easier than the cylinder head." One can readily see that the Almond engine would get in its work if the case could revolve and the shaft could not; but suppose we belt it up and drive it as an air compressor, which way would it turn the easier?

In view of the angle at which the effort of the piston impinges against the shoe and the comparative great distance the latter has to travel, it would seem that it should take considerable support from somewhere to make the shoe keep up and stay to be pushed against. Is there not, as a matter of fact, a side pressure upon the shaft equal to at least the mean effective pressure upon two of the pistons? About ten years ago a patent was issued to a man in Providence, R. I., upon an engine, which had four cylinders upon a shaft like this, only their axes were radial to the center of the shaft, and the piston effort was directed outward upon a sort of circular trolley with something like the amount of eccentricity between shaft and circular track, as in Mr. Almond's engine. The work realized in that instance would be equal to the pressure in pounds weight rolling down an incline whose vertical fall would be equal to twice the difference between the centers of the shaft and the circular track, and whose length would be equal to one-half the circumference of the track. Does Mr. Almond's tangential arrangement of cylinders double the vertical fall of the incline? If not, his engine should reverse by properly shifting the position of the ports. That would seem an anomalous position, but would be no more so than that of a locomotive bringing its crank pin forward by pushing against it in the opposite direction, which it does in the lower half of forward turn.

FRANK CARBY.

Penn Yan, N. Y.

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The Balance of the Almond Engine.

Editor American Machinist:

The letter of Mr. Fulton, on this subject, in your issue of December 2d, has suggested to me another solution of the question. He shows that the centers of gravity of the pistons are practically all at the same distance from the center of the case; but they are far from being equally quartered, which is nearly as essential as to have them the same distance from the center. From a casual

glance at the figure, it seems as though there were more weight below the center of the case than there is above it; but what harm is there in this, as long as the "heavy spot" remains below the center, whether the engine is at rest or in motion? If we had an unbalanced emery wheel, it seems to me it would run smoothly if we could only find some way to make the heavy spot revolve around the wheel in the opposite direction, and at the same speed as the wheel revolved in regard to the fixed objects in the shop.

I do not know whether this theory will hold water (or steam), but it will answer for someone to jump on, and may perhaps do duty till something more plausible is suggested.

WALTER GRIBBEN.

Brooklyn, N. Y.

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Inventor of the Turret Rotating Device.

Editor American Machinist:

In the "American Machinist" of the 7th of October Prof. John E. Sweet relates some points about the machine tools of Köpings Machine Works, exhibited at Stockholm, last summer. I am glad to state that all he writes about our tools is correct, except in one place, about our turret machine, where he says: "Besides the main turret, which has Richards' rotating device" . . . Well, that rotating device is not Mr. Richards' design, but mine. As early as 1888 I made the first turret of that kind, and since then we have been using such a turret in our own shops.

Probably Prof. Sweet has been deceived by the Richards' piston ring turning machine, fitted with such a turret. We made the first tool of that kind for Mr. Richards in the year of 1892, from his drawings, except for the turret, which I designed.

SVEN BRUNAU.

Head Draftsman at Köpings Machine Works, Köping, Sweden.

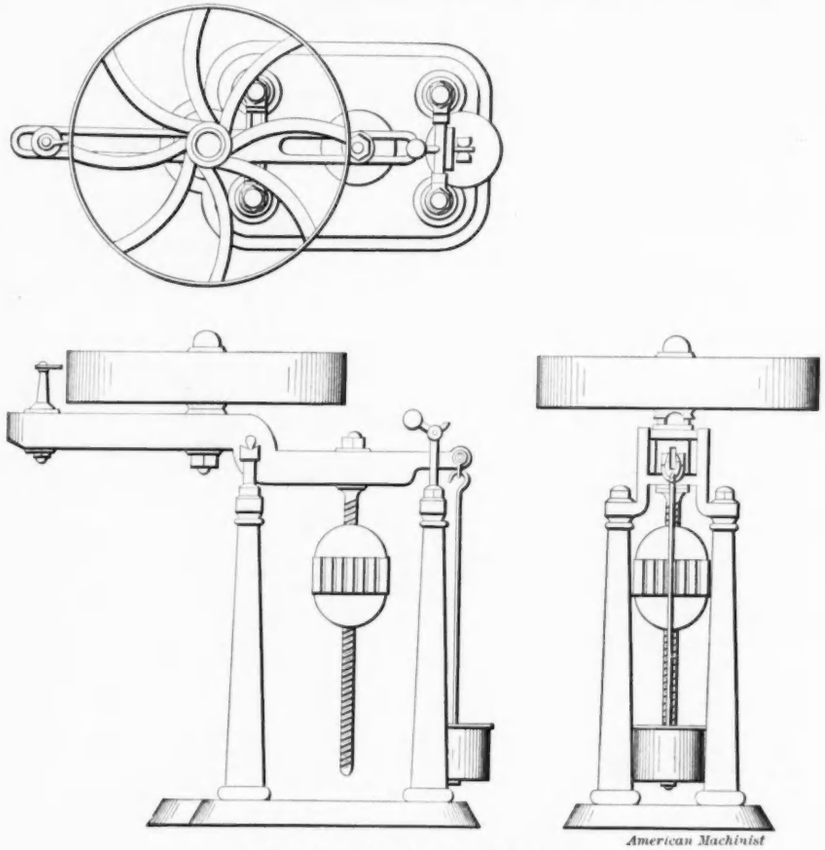
▲ ▲ ▲

A Pulley Balancing Rig.

Editor American Machinist:

The article "Pretty Near," by Mr. Tecumseh Swift, in your issue of November 18th, is a timely confession of man's inability, as far as lathes are concerned. The balancing of pulleys is perhaps not as well understood as this ingenious writer pretends. His attempt is awkward, because it goes against nature's law, and the product of such a course can never be gratifying. An absolute balance cannot be obtained when the center of gravity of the pulley is above its resting point (the heavy pieces from the big planer in this case). A better plan I have successfully used for over two years with polishing and emery wheels.

I send you a sketch of the same, with a brief description and some suggestions. Note the horizontal position of the pulley revolving upon a mandrel, fixed in the slot of beam which is supported on two knife-edge bearings. The balance ball, on the other side below, is raised or lowered until the beam attains its desired sensitiveness. The greatest sensitiveness is obtained when the center of gravity of the system is in the bearing points of the beam. When the center of gravity is below these points, the sensitiveness decreases, and when it is above varying and worthless results are obtained. The circumference of the pulley may be divided into as many equal parts, 6, 8, 10, 12 or more, as the character and size of it demand; then one division mark, turned opposite the index point (fixed at the left end of beam), makes the starting point.



A PULLEY BALANCING DEVICE.

To obtain a general idea of the uniform distributions of metal, try the pulley in different positions. Then correct the pulley in the usual manner until all points in the periphery of it weigh alike; the result will be an absolutely correct pulley.

E. MOTCHMAN.

Bellefonte, Pa.

▲ ▲ ▲

Punch and Die for Bicycle Hubs.

Editor American Machinist:

The drilling of bicycle hubs for the spokes has been given a great deal of study, and various kinds of jigs have been made to increase the output. We have recently finished a rear and front hub die that works well, and increases output a great deal more. The accompanying sketch will aid in describing them. Fig. 1 shows face of die, drilled for a hub requiring eighteen holes in each flange. Ten holes are in this die; but there are only nine punches, the remaining hole, which is indicated on the sketch, has a spring pin in it. This pin is held down by hub when punching the first nine holes. And when the second nine holes are punched (by rotating the hub half-way round), this spring pin engages with one of the previously punched holes, and properly locates the hub. The hub is held close to the locating pins on the die, and a shoulder on the die block acts as stripper, as shown. A hole is drilled in the bottom of the block to let the punchings fall out. Fig. 3 shows the punch holder and punches. The punches are driven in a tool-steel plate, and riveted so they cannot pull out. The size and length of punches depend on the spoke and design of hub. These punches were made out of No. 28 wire, turned to No. 40 at the punching end. These dies were hardened in oil, and cyanide was rubbed on before plunging. Most bicycle makers make their hubs with taper flanges; but in order to punch them, they must be made straight—i. e., of uniform thickness—as they were in this case.

H. T. GREEN.

Goshen, Ind.

Automatic Feed Stops.

Editor American Machinist:

It occurred to me, after reading Mr. Tecumseh Swift's article, in your issue of November 25th, on "Automatic Feed Stops," that something might appropriately be said in favor of the feed stop referred to.

When the stop is properly set, any number of pieces may be turned to an exact length without first having to mark the pieces with file, scratch-awl or center punch, to indicate where the tool should stop cutting; it being understood the pieces to be turned should be squared up to exact length, which should be done in any case, as variations of length would cause equal variation in the length of shoulders. Such variations would not be controlled by any stops at present being put on engine lathes. It is quite possible that a lathe with a good feed stop should be capable of turning any number of pieces exactly to length. It is especially desirable in roughing-out work, such as spindles, studs, back-gear eccentrics, etc., and I question whether an employer would argue that it was a money-loser for him, for the reason that an operative might get careless, trusting too much to the feed stop and frequently letting the lathe run without feeding. This very frequently happens whether there is a feed stop on the lathe or not. This difficulty, however, is usually rectified by the foreman or man in charge. Again, the feed stop enables the operator to feel a degree of security about his work, giving him more time to grind his tools and clean up his lathe, removing anxiety and fear of cutting beyond the length required, and consequently turning out more and better work than is usually turned out on a lathe without it.

There are cases which might be cited, where careful men have spoiled work, having been unable to disengage the feed at the proper moment. This is impossible where there is a good feed stop. There is not much danger in letting the lathe run a few revolutions after the feed has stopped, it being understood the operator is required to be at his lathe when it is running, and he should back out the tool the instant the feed stops, preventing injury to the work. There is no doubt but that some astute manufacturer of lathes would find a way to apply a tool-withdrawing device and an alarm bell, if there was any need of them, in connection with the feed stop. I believe in automatic feed stops for engine lathes, and believe in any improvement that tends to make a machine more efficient.

PETER SCHELLENBACH.

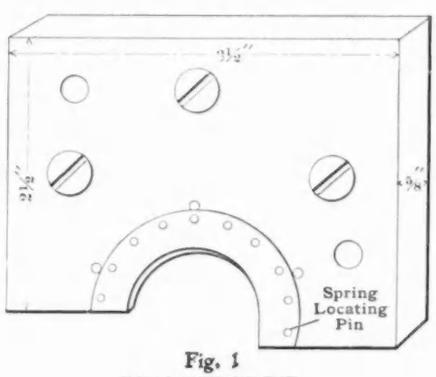


Fig. 1
TOP VIEW OF DIE

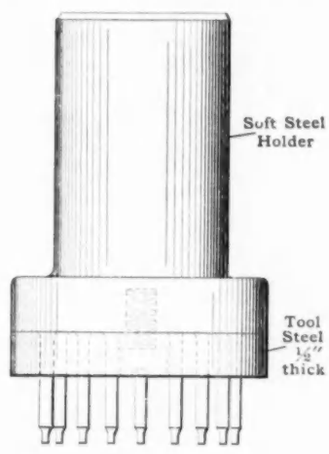


Fig. 3
VIEW OF PUNCH HOLDER
showing manner of holding small punches

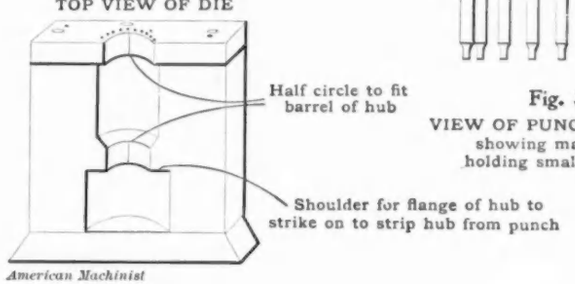


Fig. 2
FRONT VIEW
showing die fastened to cast standard

PUNCH AND DIE FOR BICYCLE HUBS.

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Salt in Lubricating Oil.

Editor American Machinist:

In the issue of November 25th of your paper is an article on "Salt in Lubricating Oils," in which Mr. E. Clement Jarvis tells how, by the use of salt and water, he succeeded in keeping an elevator worm and worm wheel cool. I would ask Mr. Jarvis to what action of the salt he attributes his success. Is salt a lubricant in itself, or did the salt and water merely have a cooling effect? For my part, I think the latter the more probable, and think all that was needed was something to keep the worm and wheel cool while it wore to a fit, and this might have been done with ice-water as well. C. O. A.

Bangor, Me.

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Too Long Hours Decrease Efficiency.

In a published account of the trip abroad of Mr. J. H. Patterson, President of the National Cash Register Company, we find the following significant passage:

When Mr. Patterson landed in Great Britain his first effort was to learn what was needed to improve the condition of our business there. He found that what was holding us back there, is holding us back in the factory, and has been holding back every other department and line of commerce. This was the fact that each man was doing work which could be delegated to the next man below him. He found that Mr. Hall and his men worked till 7 or 7.30 o'clock. "Well," said he to Mr. Hall, "that is too long. Probably you never read what Macaulay said when some one spoke of the Germans' ability to win. His answer was: 'No, they work too long. Never be afraid of a man that works twelve hours a day. The man that works but ten hours will get ahead of him.' Follow that out. Take these two hours and sit down to think what is the matter with you here. Put on more men. While it will increase the pay-roll of the office, at the same time it will increase the output 25 to 50 per cent. It is a matter of $5 against $200." Mr. Patterson's advice was followed with most gratifying results.

▲ ▲ ▲

Mr. J. A. G. Goulet, of Montreal, Canada, writes us claiming that Prof. Flather's formula for single-thickness cemented belts, which, as published in our issue of October 28th, read

$$b = 800 \frac{HP}{v}$$

should be

$$b = 825 \frac{HP}{v}.$$

We do not imagine this to have been an error on Prof. Flather's part, but that, recognizing the lack of need for over-refinement in such matters, he used 800 for a multiplier as being a round number near enough to the exact value for all practical purposes. The difference in the values of the multiplier is, in fact, far less than the uncertainty which exists regarding the coefficient of friction.

▲ ▲ ▲

The National Motor Company inform us that our notice of the Patton motor car which appeared in our issue of December 9th, contained an error, in stating that a Raymond gas engine was used in connection with the Patton motor on the car. The engine actually used was the Nash double-cylinder engine, the other particulars being correct.

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Space in advertising pages only is for sale.
We invite correspondence on subjects pertaining to machinery.
Name and address must always be given, though not necessarily published.
Communications for or relating to the reading columns should be addressed to the Editor. All business communications should be addressed to the Company.
Subscribers can have their mailing address changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once. Date on wrapper denotes week with which subscription expires.

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The Personal Equation.

Both theoretically and practically, we always expect to recognize the influence of personal predilections and prejudices in things mechanical. It is perhaps doubtful if the full power and importance of them are usually appreciated. Two very different views of this matter have lately come before the engineering world that are worth looking into a little. "The Engineer," London, asks why machines for the same purpose are not always alike. The assumption seems to be that there must be a best or a perfect way of doing a thing, and a perfect means for the purpose, which the machine should represent. A perfect machine for any purpose could not possibly be anything but a complete duplicate of every other perfect machine for the same purpose. We all know, as a matter of fact, that the machines of different builders are never alike, unless one is a servile copy of the other. It is assumed and expected that the machines of different builders for the same identical purpose shall not be alike. It is a correct mechanical instinct which approves of this. That the devices of different designers and constructors are not alike, is attributed to the idiosyncrasies of the individuals. The idiosyncrasies of the customers have also probably much to do with it, as American builders of machinery for foreign markets are showing us.

The most lamentable thing that could occur would be the prevalence of uniformity in machine design. The personal equation which asserts itself in differentiation is the one essential condition of progress. If tools were made all alike, there would be no one better than another, there would be no continual choosing of the better, no improvement. The personal likes and dislikes, the different partial knowings of ways and means, which continually insist upon things that are not like any others that ever were, seem to be very necessary factors and helpers in our onward way. The copyist is not the improver. It is always expected, and generally with reason, that the copy will be inferior to the original. It is only independence that can possibly beget improvement.

Idiosyncracies, seem, however, to be double acting. While in the view presented above the inference regarding them seems necessarily favorable, the reverse is suggested in a paper by the manager of the Union Iron Works, at the recent meeting of the American Society of Mechanical Engineers. Mr. Dickie discusses the applicability of the various means of power transmission for the various services required upon ships of war. He shows that either hydraulic, pneumatic or electric transmission may be employed throughout any single ship, but argues that they cannot all have equal chance of success, on account of the idiosyncrasies of the officers in charge. While, personally, Mr. Dickie has had rather more to do with hydraulic transmission, and may be inclined to favor it, he is forced to confess that "officers are required to care for, and get the best out of a hydraulic system, while personally they would rather sit up all night with an electric plant than spend a moment more than the law requires with a water motor." It is hard to believe that the hydraulic and the electric systems would have equal chances under such conditions. After all, there is encouragement even in this. For electric transmission, what could be better than supervision and direction by those whose interests, real or fancied, would lie in its complete success? That any one system can secure for itself strong friendship, instead of indifference, would seem to be, so far, a positive gain, and as every dog is said to have his day, perhaps the friends of the other systems will eventually appear, and each system will then, in its turn, be at its best.

Technical Books.

LETTERING FOR DRAFTSMEN, ENGINEERS AND STUDENTS. By Chas. W. Reinhardt. 32 7¾ x 11-inch pages, 9 full-page plates and 50 text figures. Third edition. D. Van Nostrand Company.

We are glad to notice a new edition of this excellent book which was reviewed at length in our columns at its first appearance. This edition contains a new chapter on lettering for photo reproduction, and the lettering of working drawings is treated more in detail than formerly.

POWER CATECHISM. Compiled from the Regular Issues of "Power." 226 6 x 9-inch (standard) pages, with 129 illustrations. Power Publishing Company. Price $2.

The fact that the information contained in this book is of value, is best shown by the fact that its appearance is due to the exhaustion of the back numbers of "Power," where it first appeared. The book is in the question and answer style, of which we do not altogether approve. There is no doubt, however, that it is popular, and in any case it is too small a matter to quarrel about. The book covers boilers with their settings and attachments, properties of steam, chimneys, slide valve and Corliss engines, pulleys, belting and shafting. The book is from a strictly practical standpoint, and at the same time contains much real scientific information. It is far ahead of numerous other steam engine catechisms that could be mentioned. It is more especially a steam-engine runner's book, and deserves, as it will doubtless receive, a large sale.

THE ELEMENTS OF ELECTRIC LIGHTING. By Philip Atkinson. 279 5 x 7½-inch pages and 103 illustrations. Ninth revised and enlarged edition. Price $1.50.

We are glad to notice the appearance of a revised edition of this excellent work, especially as it is really revised and brought up to date. The book has done excellent service in its older editions, and in the present form will doubtless begin a new career of usefulness. It covers, in non-mathematical language, the essentials of the modern applications of dynamo electricity, with the exception of motors. Within its field no better treatise exists.

EINE SAMMLUNG VON 100 ZAHNFORMEN FUER ZAHNRAEDER. By A. Baltzinger, Strassburg, Germany. Published by the author.

This is a collection of full-size drawings of gear teeth, the wheels ranging from a pinion of five teeth, 50 mm. (2 inches, nearly) pitch diameter up to wheels having 200 teeth, 2,000 mm. pitch diameter, racks and internal gears. The method of delineation is not shown, and the drawings are evidently intended to be simply copied in the construction of gears.

APPLIED MECHANICS. By John Perry, Professor of Mechanics and Mathematics in the Royal College of Science, South Kensington. 678 5 x 7-inch pages, with 371 illustrations. D. Van Nostrand Company. Price $2.50.

The engineer who is inclined to despair at the scholastic atmosphere of the schools, and at the feeling that progress out of it is impossible because of the

prevalent method of selecting teachers, should read Prof. Perry's books. Not long since we noticed his "Calculus for Engineers," to which the present volume it a fit companion. We have not sufficient acquaintance with English technical schools to feel justified in saying they do these things better in England; but there is good reason for saying that, so far as Professor Perry is concerned, the statement would have good foundation. These books of his fairly bristle with the engineering spirit. They deal with the concrete rather than with the abstract, and no student, in reading them, need ever be bothered with the mental query, What is all this good for?

The author reads some lessons to his fellow teachers, which will bear quoting: "It is not easy to forgive men who, because they have found a study interesting themselves, make their students waste a term upon it, when only a few exercises are wanted. . . . When we find our system going with clockwork regularity and we feel no worry, we ought to realize that some change is necessary. If we find that the students are not absorbed in their work, we must understand that we teachers are in fault." Again we notice such breezy common-sense as this: "It is pedantic to say that a man must not use a formula unless he is able to prove its truth. . . . A living Northern professor of great eminence has declared that a boy ought not to be allowed to use logarithms until he is able to calculate them; he has not said that a boy ought not to use a watch or wear a coat until he is able to make them."

The book contains some calculus, though not much. The author's book on calculus is intended to overcome the student's fear of that subject, and consequently he does not hesitate to use it when it is necessary or advantageous; but, on the other hand, there is no lugging in of calculus methods when others will answer as well. All in all, the book is "practical," in the best and only proper sense of that much abused word.

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Inquiries for Machinery.

Those who make, or who may know of the makers of such machinery as is called for below, will oblige us by sending name and address, mentioning the number of the inquiry. We cannot forward catalogs. We have inquiries as follows:

15. For a hat block copying lathe.

16. For machinery for putting labels on round and flat boxes or bottles.

17. For manufacturers of pearl button machinery.

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Personal.

Mr. John J. Muir, formerly chief draftsman, has been appointed to the position of master mechanic of the Bass Foundry and Machine Works, Fort Wayne, Ind.

Mr. W. J. Corrington has been made manager of the St. Louis branch of the Davis & Egan Machine Tool Company. He was formerly connected with the main office, at Cincinnati, O.

We will consider it as a favor if our readers will send in items of news regarding changes of foremen, superintendents or others prominently connected with the machine business. Such items are legitimate news of the trade, and we are glad to make room for them.

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Obituary.

George W. Eddy, inventor and manufacturer of the Eddy valve and fire hydrant, died at his home, Waterford, N. Y., on December 5th. Mr. Eddy was born in Weathersfield, Vt., in 1810. He settled in Waterford in 1830. In 1847 he established the Mohawk & Hudson Foundry, and later the Eddy Valve Works.

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Nicks in the cutting edges of a bit found in the possession of burglars in New York were found to correspond with the borings from a door in Philadelphia, where cracksmen had recently made a rich haul. The workmen were known by their chips—a warning to us all to keep our tools in good condition.

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Questions and Answers.

Name and address of writer must accompany every question. Questions must pertain to our specialties and be of general interest. We cannot undertake to answer questions by mail.

(175) J. A. G., Johnsonburg, Pa., asks: 1. How many pounds of good seasoned wood are equal to a pound of coal? A.—About 2½ pounds. Weight for weight, there is little difference in the heating value of different woods. It is important that the wood be dry. 2. How many cubic feet of natural gas are equal to 1 pound of coal? A.—About 15.

(176) Rockford, Wilmington, Del., writes: Will you tell me the average life of the wire cables that are used on the Broadway cable road? A.—Mr. M. G. Starrett, assistant chief engineer of this road, informs us that the upper Broadway cables have an average life of 30,000 miles; the Columbus avenue cables, about 25,000 miles; while the life of the cables on the lower Broadway sections is less than either of the above, varying with the season and travel.

(177) J. W. L., Chatham, asks for rules for condensers. A.—The volume of jet condensers is from ¼ to ½ of that of the cylinder. In marine steam engines the allowance for injection water in the temperate zone is from 27 to 30 times the weight of the steam. The area of the injection orifice is made equal to the weight of the injection water in pounds per minute divided by 650 to 780. In surface condensers the allowance of condensing surface is as follows:—

Term'l pres. lbs. abs.,	30	20	15	12½	10	8	6
Square ft. per I. H. P.,	3	2.5	2.25	2	1 8	1.6	1 5

(178) L. E. S., Sacramento, Cal., asks: What horse-power will be transmitted by a double belt, 24 inches wide, running on two pulleys, each 69 inches diameter, and 125 revolutions per minute? A.—Allow 50 square feet of belt per minute to transmit 1 horse-power. The square feet of belt per minute in this case will be 5.75 (diameter of pulley in feet) × 3.14 × 2 (width of belt in feet) × 125 ÷ 50 = 90.275 horse-power. Some authorities give not over 40 square feet of belt per horse-power for double belt, which would give a result 25 per cent. higher than the above. The belt will probably easily transmit 100 horse-power.

(179) J. L., New York City, asks: What will be the horse-power of the following rope transmission: Sheaves, 6 feet diameter, six 1½-inch V-grooves, 150 revolutions per minute, take up carriage with about 700 pounds weight on cable of same? A.—The question fails to give some of the essential particulars, as, for instance, the diameter and kind of rope used. The tension on the take up probably has little to do with the case. The velocity of the rope will be 6 × 3.14 × 150 = 2,826 feet per minute. Flather gives for 1¼-inch manilla rope at 2,500 feet per minute 13.1 horse-power, and for 1½-inch rope at the same speed 18.86 horse-power. For 3,000 feet per minute, the powers would be 15.39 and 21.87, respectively; this, of course, for each rope.

(180) B. J. W., Jeffersonville, Ind., asks: 1. Where can I obtain a small quantity of liquid air, say a gallon or less? A.—Liquid air has not yet become an article of commerce, and we do not believe that it is procurable. The air-compressing plants which made possible the production, incidentally, of a small quantity of liquid air in this city, are not now in operation. 2. Would it be possible to ship it any considerable distance? A.—As the temperature must not rise above 200 degrees below zero, the difficulty of preservation or of shipment is sufficiently evident. 3. Could it be used to run a bicycle by carrying a small quantity, and allowing it to escape, drop by drop, into a receiver, where it would be warmed and furnish compressed air to propel the wheel? A.—The suggestion is impracticable. Sufficient power could not be realized to maintain a run of practical length.

181) A. G. C., Milwaukee, Wis., asks for the method of solving the problem $\sqrt[3.42]{.555}$ by logarithms. A.—This is is one of those cases in which some ingenuity is required. Referring to a table of logarithms, we find the decimal part of the logarithm of .555 to be .744293, while the characteristic is — 1., giving

$$\log .555 = \bar{1}.744293.$$

In this logarithm, the characteristic is negative, while the decimal part is positive. To extract the root, the logarithm as a whole must be divided by 3.42, and the negative characteristic must be so manipulated as to be exactly divisible by 3.42. If 2.42 be both subtracted from and added to the logarithm, its value will not be changed, and, doing this, we may write:

$$\log .555 = \bar{1}.744293 = -3.42 + .744293 + 2.42.$$

If this be now divided by 3.42, the result will be

$$\frac{-3.42 + .744293 + 2.42}{3.42} = -1 + .217629 + .707602 = \bar{1}.925231.$$

which a table of logarithms shows to be the log of .84184. Cases like this are very apt to arise in extracting roots of decimals. The method shown seems somewhat cumbersome, but logarithms furnish the only method of solving many such problems.

Commercial Review.

NEW YORK, Saturday Evening, Dec. 18

THE SATURDAY AFTERNOON OF THE YEAR IN THE ENGINE MARKET.

It is apparent that the tone of the steam-power machinery industry is improving. Business in this line has, upon the whole, been growing healthier and more vigorous up to the holiday period, and its prospects for the coming year, as well as its retrospect over the latter portion of the year just coming to a close, are bright and reassuring.

Inquiries now in the field for engines and boilers are numerous. After about the middle of January, 1898, when business begins to buckle down for the coming year, we may look for better sales than have been known in any winter for many a long year past. The year 1897 has not seen a boom in the engine business, but it has witnessed a material progress toward recovery from dullness and depression. To outward appearance, the engine market has been among the tardy ones in experiencing the business revival, although improvement in a line of trade sometimes materially develops before its votaries are willing to acknowledge that there is any particular change; and it is only by looking back from the future that one can realize how much ground has been gained.

The great activity in electrical machinery renders it inevitable that the steam plant manufacturers should be at least tolerably busy, for it is astonishing to consider the extent to which these two industries have come to going hand in hand. The engine companies do not appear, however, upon the average, to be quite so busy as the electrical. Perhaps this may be due, in part, to the fact that the former are so numerous. It must be remembered that they represent an industry which has been much longer established, and that their number naturally swelled long ago to accommodate itself to the extensive use of power. The present revolutionary developments in manufacturing methods caused by the growing indispensability of the electric current can hardly be supposed to represent a corresponding increase in the employment of power, but, in part, a mere change in the mode of its application. This is evident so far as factory work is concerned, but in lighting and street railway, the demand for engines must be augmenting proportionately with that for dynamos and motors.

One of the most remarkable records of the year, in the engine business, is that made by the Edward P. Allis Company, of Milwaukee, who are equipping the engine end of many foreign tramway systems for which the General Electric has contracted to furnish the electrical machinery. It is but fair to say, that the enterprise which they and others have displayed is a matter of more than private congratulation. It marks a distinct step in establishing the prest'ge of American machinery abroad and in the commercial progress of the nation.

Among the latest export work contracted for by the E. P. Allis Company is that of furnishing some more machinery for the South African Consolidated Gold Fields. They have already sold about $1,000,000 worth of machinery destined for that point, and expect to furnish a great deal more in the future. They are crowded with work, and are building an addition to their shop, which will give accommodation to 600 or 800 more men.

We have made inquiries concerning the state of activity of a good many engine concerns, etc., and we find that some few are running on double time; quite a number are upon extra time with their ordinary force—that is, until about ten o'clock at night—while others are satisfied with their customary hours.

In some respects the West seems to be in better shape, commercially, than the East. A prominent engine seller, who has just been spending several weeks in the West, reports business conditions bright; for instance, in Denver and Kansas. On the other hand, we are informed that certain leading engine-building concerns in Rhode Island, are doing very little. Although the West may be more active than the East, it is doubtless very largely Eastern capital which is there involved.

Among the later engine contracts which have been placed for local office-building purposes, may be mentioned that for two

(Continued on page 35.)

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Business Specials.

Gear wheels, gear cutting. Grant; see page 16.

Forming Lathes. Mer. Mach. Tool Co., Meriden, Ct.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.

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Wants.

Situations and Help Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. The Cash and Copy should be sent to reach us not later than Saturday Morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Situations Wanted.

Experienced mech. draftsman. Box 137, AM. MACH.

Dftman. or fmns. asst., exp. $500,000 worth mchy., tools, popular inventions; ref. Box 412, Derby, Ct.

Sit. Wanted—By A1 Gisholt trt. lathe or eng. lathe hand; has hndld. men and mchs. Box 140, AM. MACH.

Mechanical superintendent will be at liberty Jan. 1, owing to consolidation of business; 8 years in last place. Box 139, AMERICAN MACHINIST.

Wanted—Position as foreman tool maker or supt.; competent designer and constructor; 11 years shop and 4 yrs. drftg.; bicyls. or spec. Box 135, AM. MACH.

Position as supt. or foreman, in office or works, wanted by exp. engr. and mach., fully comp. to plan, erect, start, compit. pwr plant. Box 129, AM. MACH.

Wanted—Position by superintendent who understands his business, who wants to change the first of the year. Address Box 117, care AMER. MACH.

An energetic and progressive young man desires pos. as foreman in genl. mch. shop; could introduce the mfr. of spec. mach. Box 125, AMERICAN MACH.

First class draftsman and mechl. engineer; 20 years varied exp.; designer of high grade eng., etc., open for eng. Address Box 10, Painted Post, N. Y.

Practical, up-to-date die, tool and jig maker wishes change; expert on sewing mch., typewriter, clock, bicycle and novelty tools; draftsman; capbl. of taking charge; A1 refs. Ad. "Yank," AM. MACH.

Young active, up-to-date mechanic employed at present in large mch. establishment for 17 years, desires position as salesman or outside man; undsts. hndlg. men and hydlc. mchy. Box 136, AM. MACH.

An A1 machinist, 10 years experience on installation of power plants for electric lighting and rway. work; draftsman; good general electric knowledge, estimating, etc.; single, go anywhere; des. place with eng. co.; refs. Box 275, Greenwich, Conn.

Bicycle foreman, up in every detail connected with mch. rooms, seeks engagement as general foreman of mfg. dept. with firm desiring young energetic man. Held present position 5 years; good dftmn.; age 31; American. Box 138, AM. MACH.

Help Wanted.

Wanted—An experienced detail draftsman; state experience and wages. Box 119, AMER. MACHINIST.

Wanted—Traveling salesman on machine tools in the West; must be a practical machinist. M. E. preferred. Box 134, AMERICAN MACHINIST.

Wanted—Foreman, for wood-working dept. of passenger and freight elevator co., in Western Illinois. Address Box 133, AMERICAN MACHINIST.

Wanted—A foreman patternmaker for a gen. fdy. & mch. works; must be familiar with gearg.; exp., wages. Broadway Fdy. & Mch. Works, Albany, N. Y.

Wanted—Men acquainted with the mchy. and mfg. trade to sell our goods as side line or exclsvy.; lib. com. Howard Oil & Grease Co., Cleveland, O.

Wanted—Foreman to take charge of manufacturing small articles, having had exp. in the manufacture of such articles as door locks and kindred goods. Box 123, AMERICAN MACHINIST.

Wanted—First-class draw die and forming tool maker for electrical socket and cutout work; apply stating wages and experience, to Canadian General Electric Co., Limited, Peterboro, Ont.

Foreman boiler maker for shop mfg marine and stationary boilers and tank work. Must be first class and capable of handling men to best advantage. Address, stating experience, to Box 108, AM. MACH.

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Miscellaneous Wants.

Advertisements will be inserted under this head at 30 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d h'd lathes & planers. S. M. York, Clev'd, O

Dies & Die Mak'g, $1. J. L. Lucas, Providence, R. I

A second-hand iron planer, about 3-foot bed. 368 Atlantic Ave., Brooklyn, N. Y.

The Dutton Wet Twist Drill-Grinder is sold by the Garvin Machine Co., New York City.

Bent and cheapest Bolt Header, made by Bausch & Harris Machine Tool Co., Springfield, Mass.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Boye, Cincinnati, O.

Wanted—A small machine shop in New York City. Address Box 118, care AMERICAN MACHINIST.

We make a specialty of Shartle's patent safety set collars. Prices low and samples free. Middletown Machine Co., Middletown, Ohio.

For Sale—One second-hand 400 lb. Morgan steam hammer, in good order, at a bargain. Machinery Exchange, 13-15 No. Canal St., Chicago, Ill.

Wanted—To manufr. for respons. parties sheet metal stampgs., ptns., models, dies for metal, leather, cloth or paper. Bell Elec. Co., 46 E. 14th St., New York.

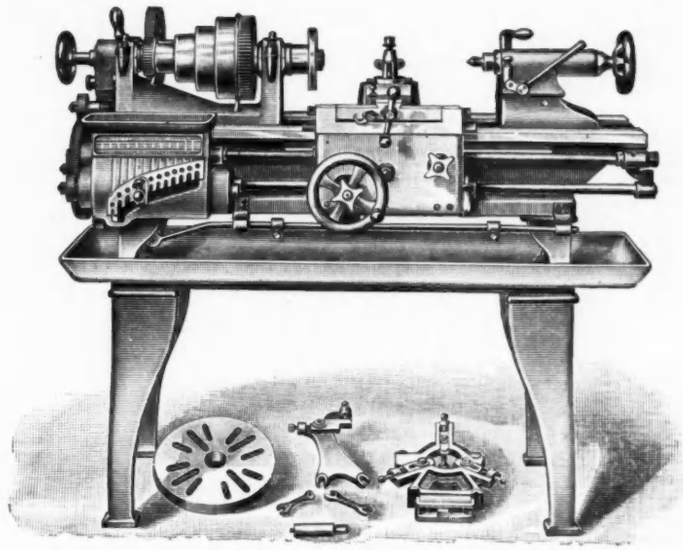
For Sale—A foundry fitted for making light gray iron castings with fine stock of patterns. A well equipped jobbing machine shop attached. Box 132, AMERICAN MACHINIST.

Lathes, planers, drills, milling machines, vises, also brass working machinery second-hand; must be modern and in first-class condition. C. C. Wormer Machinery Co., Detroit, Mich.

Columbia University
in the City of New York.

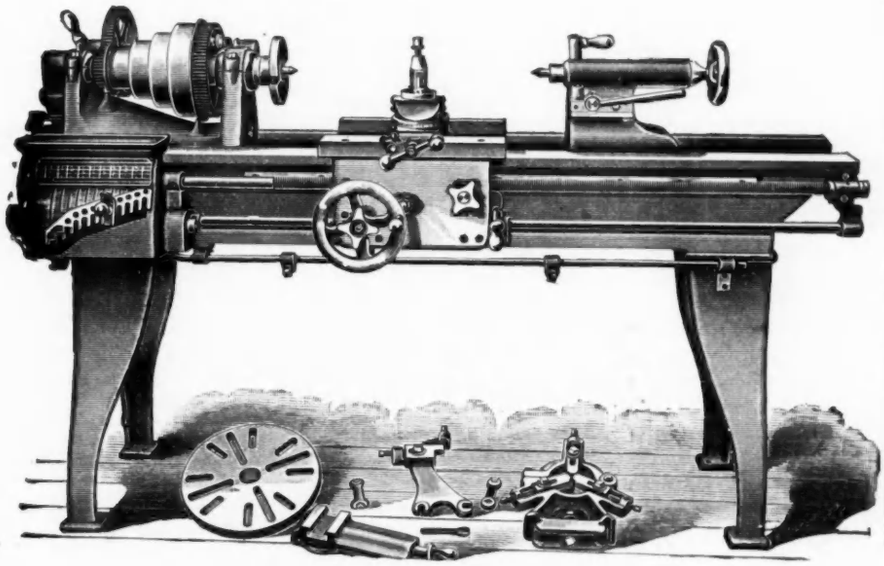
SCHOOL OF MINES,
SCHOOL OF CHEMISTRY,
SCHOOL OF ENGINEERING,
SCHOOL OF ARCHITECTURE,
SCHOOL OF PURE SCIENCE.

Four years' undergraduate courses and special facilities for graduate work in all departments. Circulars forwarded on application to the Secretary of the University.



12" Hendey-Norton Lathe

is fitted with drawing-in sleeve and American Watch Tool Co's standard chuck, used in making small taps, reamers, etc. Work finished first and cut from bar afterwards. No centering required. See carriage reverse lever by right-hand side of apron; no reaching for countershaft shipper required.



14" x 6' Hendey-Norton Lathe.

These lathes are modern, high-grade, practical tools, and are specially adapted for tool-room work. They have the Norton Attachment for screw cutting, giving 36 different threads and 36 different feeds with only two changes of gear and movement of lever in gear-box from one notch to the other. Note the automatic stop under apron. It will automatically stop carriage at any desired point in either direction; invaluable for internal or duplicate work. SEND FOR CATALOGUE.

The Hendey Machine Company,

Torrington, Conn.

Agents for the Pacific Coast, Pacific Tool & Supply Co., San Francisco, Cal.

European Agents, { Schuchardt & Schütte, Berlin, Vienna, Brussels, Stockholm. Chas. Churchill & Co., Ltd., London and Birmingham, Eng. Adphe. Janssens, Paris, France. Eugen Soller Basel, Switzerland.

(Continued from page 34.)

Ames engines for the Exchange Court Building, which had already ordered at least four of that make. The General Electric Company furnish the electrical machinery. Three Payne engines are ordered for the Gill Building, Broadway and Maiden Lane. The new building now going up on Park Row, which will be, when completed, probably the highest in the city, is said to have ordered Babcock & Wilcox boilers. It will require six or eight engines of from 250 to 400 horse-power each. A United States Government boiler contract, that for the Appraiser's Stores, in this city, is about to be awarded. It was specified to comprise either three water-tube or five fire-tube boilers. The lowest bid is said to have been put in on National Water Tube boilers.

We understand that another mammoth hotel—the Bruce-Price—is to be erected in New York city, opposite the Grand Central depot. It is stated that its power plant will be from 33⅓ to 50 per cent. larger than that of the Astoria, and will have a separate boiler and engine house built for it. When the electrical plant for the Astoria was ordered, it was considered about the largest isolated plant in the world, and doubtless the future machinery contractors for the Bruce-Price will be able to advertise themselves by doing some further record-breaking.

The Weston Engine Company are experiencing the most busy time in their history. They have been behindhand some thirty-five engines for a month or so. One of the most recent orders is a State job from Marion, Ind.

An engine company situated in this State, which has been notoriously busy for a year or two past, continues to be rushed with work. In the offices, sales have just been made of three engines for shipment to Glasgow, and among the latest foreign demand is that coming this week from Japan and Buenos Ayres. All these are for electrical purposes.

The Westinghouse Electric and Manufacturing Company has contracted to equip the Glasgow Tramway Corporation, of Glasgow, Scotland, with street railway machinery; as well as to furnish apparatus for lighting the city of Malaga, Spain, where formerly only European material has been used. Perhaps it is in connection with the former contract that the engines above alluded to have been ordered from Glasgow.

The Abendroth & Root Manufacturing Company are running until 9 or 10 o'clock P. M. on pipe-making. Boilers they find somewhat quiet, but there are some excellent inquiries for them now coming in.

A leading New England pump company reports business improved since the election. The factory has all the work on hand that it can attend to, but is not running on night turn.

The Westinghouse Machine Company

has of late been enjoying the reputation, in engineering circles, of being one of the busiest of the engine builders.

The 1897 trade of the Harrison Safety Boiler Works has been the best for several years past.

The Oil City Boiler Works are running overtime.

The Watertown Engine Company, which is enjoying a good business, has been running overtime of late, and may be doing so still. They have just been buying machine tools for working up engine frames.

The factory of the Buckeye Engine Company ran extra hours for a number of weeks not long ago.

The Russell Engine Company is running overtime with its ordinary complement of men. Certain operations, viz., turning shafts and fly-wheels and boring cylinders, are kept going continually. A recent good-sized order is that placed with them by Arbuckle & Ryan, of Toledo, O., for two engines of some 500 horse-power each, for street-railway purposes.

There is interesting competition now going on in the water-tube boiler market. A certain company, which we need not name, succeeded in past years in securing the lion's share of the market prey. Now they are rivalled by a concern which handles a boiler of the same general type as their own, as well as a boiler of another pattern. The new concern has the grit to make low prices, and the old one has the money to meet them. So the conservative companies sit on the fence and watch the fun. We heard of one of the latter which are cogitating whether to build a new factory in order to bring their producing facilities up to date, and jump down from the fence to take a hand themselves.

Quotations.

NEW YORK, Monday, December 20.

Iron—American pig, tidewater delivery:

No. 1 foundry, Northern	$11 75 @ $12 00
No. 2 foundry, Northern	11 25 @ 11 50
No. 2 plain, Northern	10 75 @ 11 00
Gray forge, Northern	10 25 @ 10 50
No. 1 foundry, Southern	11 00 @ 11 25
No. 2 foundry, Southern	10 50 @ 10 75
No. 3 foundry, Southern	10 25 @ 10 50
No. 1 soft, Southern	11 00 @ 11 25
No. 2 soft, Southern	10 75 @ 11 00
Foundry forge, Southern	10 00 @ 10 25

Bar Iron—Base—Mill price, in carloads, on dock: Common, 1.10c.; refined, about 1.20c. Store prices: Common, 1.25 @ 1.35c.; refined, 1.30 @ 1.50c.

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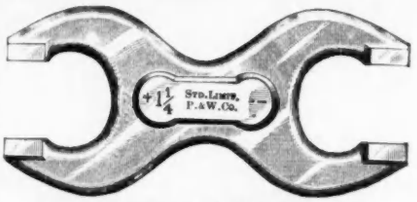

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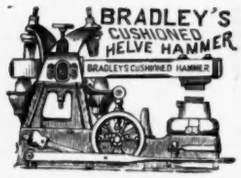

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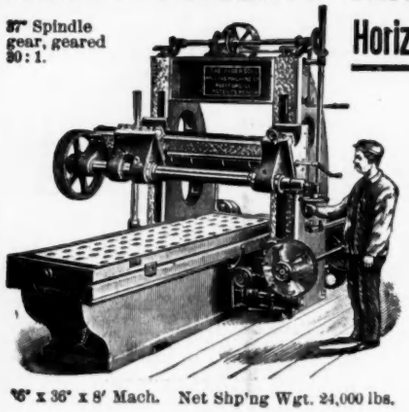

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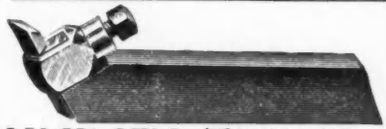

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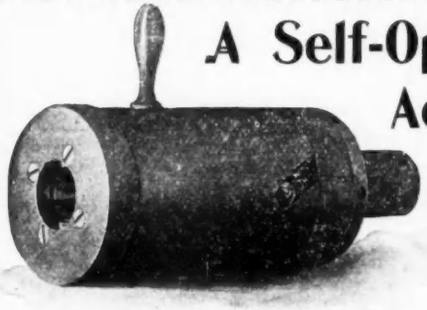

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At Castorland, N. Y., Mr. S. F. Virkler intends to build a new mill.

At Riverside, Cal., work on the Colonia Sugar Factory has commenced.

The W. H. Howell Company, at Geneva, N. Y., is to erect a new factory.

At Northampton, Pa., the Atlas Cement Company will erect a cement plant.

At Des Moines, Ia., the J. H. Cownie Glove Company is to construct a brick factory.

The Portage Iron Works, at Duncansville, Pa., is to add a new steel wire nail mill.

The Huber Manufacturing Company, Harrisburg, Pa., is to erect a new machine shop.

The Western Electric Company, Chicago, is to make extensive additions to its factory.

The Etna-Standard Iron & Steel Company, of Bridgeport, O., will add new machinery.

The Somersville (Conn.) Manufacturing Company has laid the foundation for an addition.

The works of the Pfaff Carriage Company, at Ashtabula, O., has been destroyed by fire.

The Exeter Machine Company, of Pittston, Pa., is to erect a new molding shop, 84 x 74 feet.

The Star Milk Cooler Company, of Haddonfield, N. J., is to erect a factory at an early date.

The Keller & Holt planing mill at Harriman, Tenn., recently destroyed by fire, will be rebuilt.

It is expected that the W. Dewees Wood Company will erect a steel mill near Elizabeth, Pa.

The Turner Engineering Company, of Marion, O., has about completed plans for new shops.

The Fort Wayne (Ind.) Electric Company is contemplating an addition to its plant at an early date.

At Minto, Ore., the Lawler mines have closed down with the intention of putting in more machinery.

The New Holland Cigar Manufacturing Company's plant at Lancaster, Pa., was recently destroyed by fire.

The Numsen Manufacturing Company, of West German street, Baltimore, Md., is to erect a new factory.

The Hart Manufacturing Company, of Cleveland, O., are so busy as to warrant an enlargement of their plant.

At Waterville, Me., a new company, known as the Lombard Patent Manufacturing Company, is being formed.

J. R. Mowen & Sons have the contract for building the new works for Frank F. Fee's plant in South Lima, O.

Plans for the roundhouse at Bedford, Ind., have been completed by Chief Engineer Hall, of the Monon Railroad.

At North Brookline, Mass., Mr. H. Marshall & Bro., of Boston, are to erect a building for the manufacture of wooden type.

Alden Speare's Sons & Co. are to erect a starch mill at Cambridge. This company has houses in Boston and New York.

The Crown Plaster Company, of Lock Haven, Pa., is erecting a mill in West Braddock to manufacture wall plaster.

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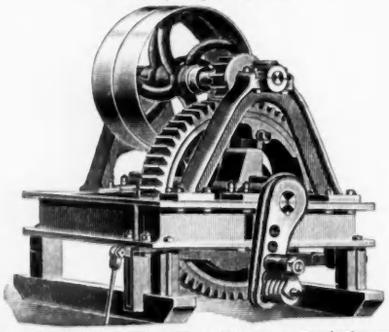

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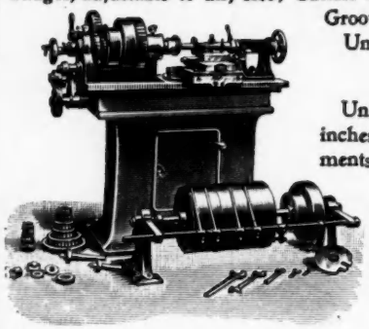

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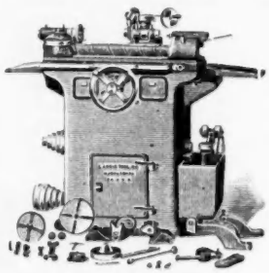

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